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Preliminary Data Summary for Industrial Laundries

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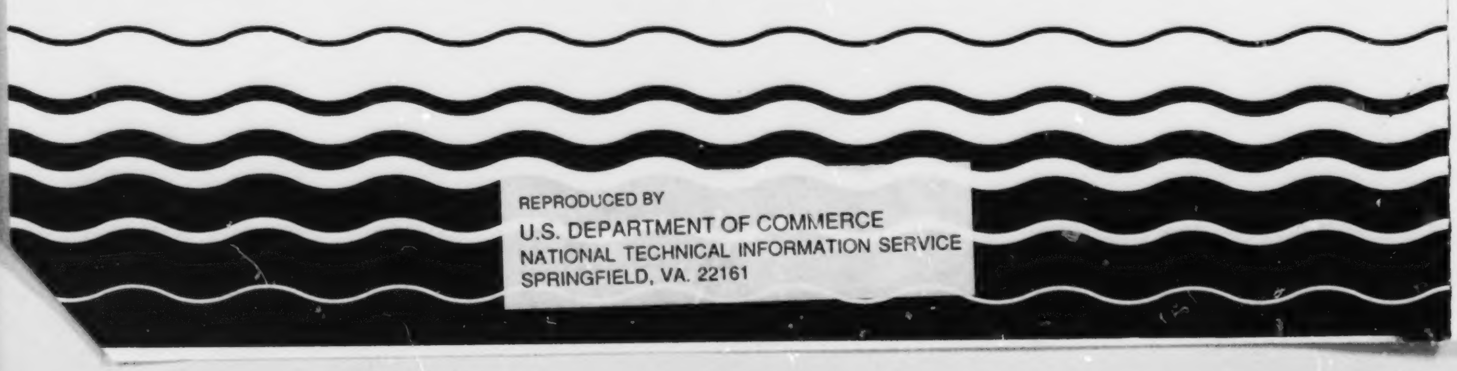

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This document is one of a series of Preliminary Data Summaries prepared by the Office of Water Regulations and Standards of the U. S. Environmental Protection Agency. The Summaries contain engineering, economic and environmental data that pertain to whether industrial facilities in various industries discharge pollutants in their wastewaters and whether the EPA should pursue regulations to control such discharges. The summaries were prepared in order to allow EPA to respond to the mandate of Section 304(m) of the Clean Water Act, which requires the Agency to develop plans to regulate industrial categories that contribute to pollution of the Nation's surface waters. Summaries for categories already subject to rulemaking were developed for comparison purposes, and contain only the minimum amount of data needed to provide some perspective on the relative magnitude of the pollution problems created across the categories. → con't on PG!

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PREFACE

This is one of a series of Preliminary Data Summaries prepared by the Office of Water Regulations and Standards of the U.S. Environmental Protection Agency. The Summaries contain engineering, economic and environmental data that pertain to question as to whether the industrial facilities in various industries discharge pollutants in their wastewaters and whether the EPA should pursue regulations to control such discharges. The summaries were prepared in order to allow EPA to respond to the mandate of section 304(m) of the Clean Water Act, which requires the Agency to develop plans to regulate industrial categories that contribute to pollution of the Nation's surface waters.

The Summaries vary in terms of the amount and nature of the data presented. This variation reflects several factors, including the overall size of the category (number of dischargers), the amount of sampling and analytical work performed by EPA in developing the Summary, the amount of relevant secondary data that exists for the various categories, whether the industry had been the subject of previous studies (by EPA or other parties), and whether or not the Agency was already committed to a regulation for the industry. With respect to the last factor, the pattern is for categories that are already the subject of regulatory activity (e.g., Pesticides, Pulp and Paper) to have relatively short Summaries. This is because the Summaries are intended primarily to assist EPA management in designating industry categories for rulemaking. Summaries for categories already subject to rulemaking were developed for comparison purposes, and contain only the minimal amount of data needed to provide some perspective on the relative magnitude of the pollution problems created across the categories.

PRELIMINARY DATA SUMMARY FOR THE INDUSTRIAL LAUNDRIES INDUSTRY

Office of Water Regulations and Standards
Office of Water
United States Environmental Protection Agency
Washington, D.C.

September 1989

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SUMMARY

The U.S. Environmental Protection Agency has conducted a study of the industrial laundries industry in response to a recommendation made in the Domestic Sewage Study and because of concern for the potential discharge of toxic and hazardous pollutants. The purpose of the study was to prepare a document to assist the Agency in deciding whether to develop national effluent limitations guidelines and standards for the industry. The document comprises three studies, undertaken independently, listed as follows:

- a technical support study
- an economic impact study
- an environmental impact study

The technical support study consisted of two parts: the collection and analysis of industrial laundry wastewater and waste solids samples, and the collection of sufficient information about the industry to develop a preliminary updated industry technical profile. The economic impact study consisted of a review and update of the economic profile of the industrial laundries industry and an analysis of the projected economic impact of wastewater regulation on the industry. The environmental impact study is an evaluation of the impacts of industrial laundry wastewater discharges on publicly operated treatment works and their receiving streams.

Industrial laundries (SIC 7218) are primarily engaged in supplying laundered or, to a limited extent, dry-cleaned work uniforms, wiping towels, safety equipment (gloves, flame-resistant clothing, etc.), dust covers and cloths, and similar items to industrial or commercial users. These items may belong to the industrial launderers and be supplied to users on a rental basis, or they may be the customer's own goods. Most industrial launderers offer their customers a variety of textile maintenance services, but approximately 88 percent of their receipts in 1974 were derived from the activities defined above. The estimated 28,400 plants that are primarily engaged in dry cleaning or dyeing apparel and household fabrics for the general public belong to SIC 7216 and are not included in this study.

Samples of raw wastewater, and treated final effluent at laundries with wastewater treatment facilities, and waste solids were collected and analyzed for a wide variety of hazardous and nonhazardous pollutants. The results of the analyses showed that any of a large number of hazardous organic or metallic pollutants may be found in industrial laundry wastes at concentrations that vary widely with location and time. Some hazardous pollutants were found at levels above 10 mg/l. BOD_5, TSS, and oil and grease levels average approximately 1000 mg/l.

Wastewater analytical data were used to estimate the industry's annual raw waste pollutant mass loadings for several classes of organic, metallic and other types of pollutants. These estimated raw waste loads are presented in the Summary Table.

SUMMARY TABLE

SUMMARY OF THE ESTIMATED ANNUAL RAW WASTE MASS LOADINGS OF THE INDUSTRIAL LAUNDRY INDUSTRY

Pollutants	Mass Loading (1000 lbs/yr)	(1000 lbs/yr)
Conventional Pollutants		
BOD_5	165,000	
TSS	154,000	
Oil and grease	148,000	
Subtotal		467,000
Nonconventional Pollutants		
Volatile organics	24,000	
Semivolatile organics	3,100	
Pesticides and Herbicides	200	
Metals and elements	1,500	
COD	688,000	
Subtotal		717,000
Priority Pollutants		
Volatile organics	1,500	
Semivolatile organics	2,000	
Pesticides and herbicides	30	
Cyanide	300	
Metals	1,600	
Subtotal		5,400
Total		1,189,000

Note: Mass loadings are based on an estimated population of 1,000 industrial laundries and a total industrial wastewater flow of 68 million gallons per day.

The 1978 screening and verification sampling program involving industrial laundries suggested that shop towels and cloths were a significant source of the priority pollutants (volatiles, semivolatiles, and metals) found in industrial laundry wastewater. However in 1982, the Agency excluded the Industrial Laundries subcategory from national regulations because 95 percent of all industrial laundries discharged pollutants that were susceptible to treatment by publicly-owned treatment works (POTW), and did not interfere with or pass through POTWs and were not otherwise incompatible with POTWs.

Since then there have been a number of developments that suggest a reconsideration of this exclusion may be necessary. First, the results of the ITD/RCRA sampling program suggest that shop towels are a continuing source not only of priority pollutants but many nonconventional hazardous pollutants as well. Secondly, the Agency has acquired a limited amount of data which suggests that a new technology, ultrafiltration, can be used to reduce significantly the pollutant concentrations generated by the laundering of shop towels. The Agency now has more information on the POTW volatilization of the many volatile pollutants generated by industrial laundries. Thus, the Agency may have adequate information to determine whether these pollutants pass through POTWs.

Sampling data and comments by industry personnel and treatment system operators have identified wastewater from laundering shop towels as the industry's major source of hazardous pollutants. Control and reduction of pollutants generated by washing shop towels may well reduce the total pollutant load discharged by the industry to a point where it is no longer a concern.

Economic data characterizing the industrial laundries industry were obtained from the U.S Census Bureau, the Institute of Industrial Launderers and earlier U.S. EPA Effluent Guidelines studies. The number and size of industrial laundries and the number of employees and the revenues generated per facility were determined. These data were compared with earlier data (from approximately 1980) to characterize the industry and identify trends in the industry.

The study showed that the industry comprises many rather small facilities and a few large ones which economically dominate the industry. There has been some growth in the industry in some regions of the country but overall there has been little growth either in number of employees or revenue in the last twenty years. The data suggest that the industry is slow to modernize and that productivity, although increasing, is offset by cost competition.

Three major influences on the industry are shown to be competition within an industry experiencing no significant growth, the availability of substitute goods and services, and environmental regulation. The industry personnel feel that disposable products, particularly wiping rags (shop towels) pose a threat to the industry. In addition, increased costs due to environmental regulations might cause customers to move toward in-house laundries or increased use of disposables.

The economic data gathered are used to describe the financial characteristics of industrial laundry firms and to estimate the impact on industry profits of a requirement for ultrafiltration as a wastewater pretreatment system. The data indicate that many firms in the industry operate on very slim margins of income over liabilities, have high liabilities compared to net worth and have very small operating margins. In other words, many facilities would have trouble absorbing the costs of installing and operating wastewater pretreatment systems.

Three model plant sizes were defined, based on plant revenues, on which the economic impact analyses were performed. The model plants, represented approximately the 25th, the 50th, and the 80th percentiles, respectively, of all industrial laundry establishments. The capital and operating costs were calculated for ultrafiltration pretreatment systems sized appropriately for each model plant. Finally, the impact on pretax profits of installing the ultrafiltration systems were calculated for the model mills.

Assuming that costs cannot be passed on to the customers, the analysis indicates that a requirement for ultrafiltration pretreatment may result in severe economic impacts for a large proportion of plants in the industry. The annualized cost of pretreatment is predicted to be greater than the pretax profit earned by over one-fourth of the firms in the industry. The impact is much greater on smaller firms.

The environmental impact study evaluated the impacts of fourteen indirect discharging industrial laundries on publicly owned treatment works (POTWs) and ultimately on the POTW receiving streams. Impacts on the POTWs were evaluated in terms of inhibition of POTW operations and contamination of the POTW sludges. Receiving stream impacts were evaluated by comparing estimated instream pollutant concentrations with aquatic life toxic effects levels and EPA water quality criteria.

Two data sets were used for the environmental impact analysis, one from a 1986-1987 EPA industrial laundries wastewater effluent monitoring program and one from a similar 1978 EPA program. Analysis of the 1986-1987 data set projects minimal water quality impacts. Only benzidine and arsenic exceed human health criteria and cyanide exceeds chronic aquatic life criteria.

Analysis of the 1978 data set projects water quality impacts. Six pollutants exceed human health criteria or chronic aquatic life criteria or both and two pollutants, (zinc and lead) exceed POTW inhibition levels.

SECTION 1

1.0 INTRODUCTION

Con't from BDS

This document provides the most current information available about the industrial laundries subcategory of the auto and other laundries point source category. The document comprises three studies of the subcategory; a technical support study including processes employed, waste characteristics, and wastewater treatment technologies employed (Sections 2 through 7), an economic impact study projecting the likely economic results of regulating industrial laundries wastewater discharge (Sections 8 through 11) and an environmental impact study evaluating the impacts of the industry's wastewater on the environment (Section 12).

This study of the industrial laundries industry (hereinafter called the industry study) was undertaken in response to the recommendations of the Domestic Sewage Study that EPA review pretreatment standards, collect additional data, and amend the categorical pretreatment standards as necessary, for the industrial laundries industry (among several other industries). A history of the Domestic Sewage Study and its role in focusing regulatory attention under the Clean Water Act is set out below.

1.1 Purpose and Authority

The Federal Water Pollution Control Act (Clean Water Act or CWA) Amendments of 1972 established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Section 101(a)). To implement the Act, EPA was to issue effluent limitation guidelines, pretreatment standards, and new source performance standards for industry dischargers.

The Act included a timetable for issuing these guidelines. Pursuant to the Act and a settlement agreement reached in litigation, EPA was required to develop a program and adhere to a schedule in promulgating effluent limitations guidelines, and pretreatment standards for 65 "toxic" pollutants and classes of pollutants, for 21 major industries. See Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified, 12 ERC 1833 (D.D.C. 1979). Moreover, EPA is required by section 301(d) of the Federal Water Pollution Control Act Amendments of 1972 and 1977 (the "Act"), to review and revise, if necessary, effluent limitations promulgated pursuant to sections 301, 304, 306, 307, 308, and 501 of the Act.

In 1984, Congress enacted the Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA). Section 3018(a) of RCRA, as amended, directed EPA to submit a report to Congress concerning wastes exempted from RCRA regulation as a result of the Domestic Sewage Exclusion of RCRA and discharged through sewer systems to publicly owned treatment works (POTWs). The report mandated by Section 3018(a) examined the nature and sources of hazardous wastes discharged to POTWs, measured the effectiveness of Agency programs in dealing with such discharges, and recommended ways to improve the programs to achieve better control of hazardous wastes entering POTWs. The report (the Domestic Sewage Study, hereinafter referred to as the DSS) (1) was prepared by EPA's Office of Water and submitted to Congress on February 7, 1986.

Section 3018(b) then required the Administrator to revise existing regulations and to promulgate such additional regulations as are necessary to ensure that hazardous wastes discharged to POTWs are adequately controlled to protect human health and the environment. These regulations are to be promulgated pursuant to RCRA, Section 307 of the CWA, or any other appropriate authority possessed by EPA.

The Domestic Sewage Exclusion (DSE) established by Congress in section 1004(27) of RCRA, provides that solid or dissolved material in domestic sewage is not solid waste as defined in RCRA and such materials cannot be considered a hazardous waste for purposes of RCRA. The DSE applies to domestic sewage and industrial wastes discharged to POTW sewers which contain domestic sewage, even if the industrial wastes would otherwise be considered hazardous wastes.

Under the DSE industrial facilities which discharge such wastes to sewers containing domestic sewage are not subject to RCRA generator and transporter requirements, such as manifesting and reporting. In addition, POTWs receiving such wastes mixed with domestic sewage are not deemed to have received hazardous wastes and therefore need not comply with certain RCRA hazardous waste treatment, storage, and disposal requirements with respect to these wastes. However, the DSE does not apply to sludge produced by a POTW as a result of wastewater treatment if such sludge is found to be a RCRA characteristic waste under 40 CFR 261 Subpart C.

The DSE stems from the assumption that the pretreatment program of the CWA can ensure adequate control of industrial discharges to sewers. This program, mandated by section 307(b) of the CWA and implemented in 40 CFR Part 403, requires the establishment of pretreatment standards for pollutants discharged to POTWs by industrial facilities, to prevent such pollutants from interfering with, passing through, or otherwise being incompatible with the operation of POTWs. The DSE avoids the potential regulatory redundancy of subjecting hazardous wastes mixed with domestic sewage to RCRA management requirements if these wastes are already subject to appropriate pretreatment requirements under the CWA.

The study concluded that the DSE should be retained at the present time and recommended ways to improve various EPA programs under the CWA to obtain better control of hazardous wastes entering POTWs. In addition, the Study recommended research efforts to fill information gaps, and indicated that other statutes (such as RCRA and the Clean Air Act) should be considered with the CWA to control either hazardous waste dischargers or receiving POTWs or both, if the recommended research indicates the presence of problems not adequately addressed by the CWA.

One of the main recommendations of the Study was that EPA review and amend categorical pretreatment standards to achieve better control of the constituents of hazardous wastes. The DSS recommends that the Agency modify existing standards to improve control of organic priority pollutants and non-priority pollutants, and that EPA promulgate categorical standards for industrial categories not included in the Natural Resources Defense Council consent decree (NRDC v. Train, 8 ERC 2120. D.C.C. 1976).

The Study found that some industrial sources discharging potentially hazardous wastes to POTWs may not be sufficiently regulated by categorical standards. Among these unregulated sources are industrial laundries which tend to discharge significant quantities of toxic and hazardous pollutants on a facility-specific basis.

1.2 Regulatory Background

The Auto and Other Laundries Category which includes industrial laundries as one of its subcategories was one of the industry categories mandated for study and possible effluent guidelines development by the 1977 Clean Water Act and a Settlement Agreement between the Agency and environmental groups. In 1980, the Agency did propose PSES, PSNS, and NSPS for the industrial and linen supply laundry subcategories of the industry. This proposal was later withdrawn and the industry, including the industrial laundries subcategory, was excluded from regulation by paragraph 8 of the Natural Resources Defense Council v. Costle consent decree. The basis for the exclusion of the industrial laundry subcategory was the fact that 95 percent of the subcategory dischargers discharged pollutants that were amenable to treatment by POTWs and which did not pass through, interfere with, or prove otherwise incompatible with the operation of POTWs. As stated in the previous section, the Agency may reconsider this exclusion because of recent developments.

The Agency has undertaken several studies of this industry. The first resulted in draft proposed effluent guidelines and standards and a draft proposal development document in 1974. More recent studies, occurring in 1977 through 1980 documented the decision to exclude the industry from regulation under paragraph 8 and resulted in Guidance Document for Effluent Discharges from the Auto and other Laundries Point Source Category, February 1982.

TECHNICAL SUPPORT

SECTION 2

2.0 INTRODUCTION TO TECHNICAL SUPPORT STUDY

Sections 2 through 7 of this document provide a technical study of the industrial laundries industry focused primarily on waste generation and characterization and wastewater treatment. The study reviews previous EPA wastewater studies of the industrial laundries industry and updates the EPA data base.

2.1 Introduction

The technical study provides an updated profile of the industrial laundries industry, and chemical analyses of wastewater and waste solids obtained from recent sampling episodes and recent wastewater monitoring data obtained through other authorities. The document provides a technical basis which can be used to determine whether regulations should be developed for this industry. The document will also serve as a summary of information which can be used by permit writers and POTWs in controlling hazardous wastes until final rules are published.

The industrial laundry subcategory is defined and described in Section 3 and subcategorization is reviewed in section 4. Section 5 characterizes industrial laundries wastewaters in terms of flow, concentrations and loads. Pollutants of concern are identified in Section 6, and control and treatment technologies are discussed in Section 7.

2.2 Study Methodologies

At the start of this industry study, data gathering efforts and information assessments were subdivided into the following tasks.

Review and Assessment - Previous data were reviewed, data gaps and requirements were assessed and industry opinions and assistance were obtained via a meeting with representatives of the Institute of Industrial Launderers, the Textile Rental Services Association of America, and the Alliance of Textile Care Associations.

Supplemental Data Gathering - Background information necessary to prepare a list of candidate facilities to be sampled, or necessary to update existing information on this industry was obtained from documents reporting previous Agency (Effluent Guidelines Division) studies of the auto and other laundries industry, the most recent of which are:

- Guidance Document for Effluent Discharges from the Auto and Other Laundries Point Source Category, February 1982;
- Development Document for Effluent Guidelines and Standards for the Auto and Other Laundries Point Source Category, October 1980;

- Technical Support Document for Auto and Other Laundries Industry, October 1979.

These documents and the technical record which supports them summarize the information gathered during the earlier studies. Data gathering efforts have included two data collection portfolios (1977 and 1979) and wastewater sampling and analytical programs.

Recent information used to select the facilities at which sampling episodes occurred or used elsewhere in this industry study were obtained from the following.

- telephone interviews with, and visits to, personnel at EPA Regional and State offices, industry trade associations, and representative industrial laundry facilities; and

- the literature, including research reports, journals and magazines, and computer-based abstract data bases.

Information was obtained to reliably characterize the industry's processes, subcategorization, and pollutants of concern and to determine pollutant treatability and identify possible treatment technologies.

Supplemental Data Collection Portfolio (DCP) - A DCP to supplement the 1977 DCP has been prepared and, after Agency approval, will be distributed to the industry. The DCP will furnish necessary information about current industry practices.

Sampling and Analytical Programs - A program was undertaken to obtain wastewater and waste solid samples at four industrial laundries located in different sections of the country. Information obtained during the supplemental data gathering program in conjunction with the advice and assistance from the Institute of Industrial Laundries was used to select seven laundry facilities for site visits four of which were later selected for sampling episodes.

Raw wastewater, treated effluent, and waste solids samples were obtained at each facility. The samples were analyzed for conventional and nonconventional pollutants and the pollutants on the "ITD List of Analytes" (priority pollutants plus approximately 200 additional organic compounds). Sludge leachates from solids samples were also analyzed for the compounds on the ITD list.

Industrial Profile and Subcategorization -The detailed information collected in previous data gathering efforts was the basis for the industry profile presented in documents referenced above. Information collected during the present study has been compared to earlier information to update, and revise as necessary, the industry profile and subcategorization scheme. Additional information will be obtained from the DCP after it is distributed and returned.

Water Use, Solids Generation, and Waste Characterization - The data base established previously by EPA and the new data was reviewed to update the water use and waste characterization for the industry. The available literature about industrial laundries was reviewed and data collected during the sampling program and from state and municipal authorities were evaluated.

Selection of Pollutant Parameters - The analytical data base was updated to include data obtained both during previous industry studies and during this industry study. The data base was reviewed with respect to levels, frequency of occurrence, and relative toxicity of pollutants found in the wastewaters and waste solids generated by the industrial laundries industry to identify pollutants of concern.

Assessment of Control and Treatment Technologies - Previous and new waste treatment information and data on full scale, pilot scale, and laboratory scale in-plant controls and treatment systems were evaluated. Literature on in-plant controls and treatment systems were collected and reviewed. As part of the control and treatment technology assessment, pollutant reduction and treatability were evaluated to determine the effluent levels attainable by the various technologies.

Information for technologies used in other industries to remove any of the significant pollutants identified in this industry category was obtained and reviewed to determine if the technologies can be applied to the industrial laundries.

SECTION 3

3.0 DESCRIPTION OF THE INDUSTRY

This section consists of a general profile of the industrial laundries industry including size, products, and trends since previous EPA studies of the industry, and a description of the laundering processes used by the industry.

3.1 Industry Profile

Industrial launderers, Standard Industrial Classification (SIC 7218), operate establishments which primarily supply laundered or dry-cleaned work uniforms, wiping towels, safety equipment (gloves, flame resistant clothing, etc.), dust covers and cloths, and similar items to industrial or commercial users. These items may belong to the industrial launderers and be supplied to users on a rental basis or they may belong to the customer.

There are 1288 operating industrial laundries (SIC 7218) according to the 1982 Census of Service Industries. Of these, approximately 1000 operate their own laundry or dry-cleaning facilities and the remainder are mostly sales establishments or administrative or distribution centers. This study is concerned only with those that operate laundering or dry-cleaning processes.

Industrial laundries, because of the nature of their business, are mostly located in metropolitan areas, normally close to their customers. They are located throughout the United States but about half are found in the seven most densely populated industrial states. Because of their metropolitan locations, almost all industrial laundries discharge to publicly owned treatment works.

The laundries industry, as characterized by its labor force and equipment usage, has been slow to modernize. The industry is extremely labor intensive, with about one-third of the labor force earning minimum wages. The industry is also conservative in equipment usage as equipment has not changed greatly in design in recent years. Basic laundry equipment is durable and there is a strong tendency in the industry to purchase used or rebuilt machinery when replacing equipment. However, economic forces are causing some changes. For example, the shortage in unskilled labor is forcing the industry to begin to convert to more modern, partly or fully-automatic labor-saving equipment.

Most industrial launderers offer their customers a variety of textile maintenance services but more than 80% of the total weight of material cleaned by industrial laundries consists of industrial garments (such as uniforms, coveralls, work shirts, and pants), industrial flatwork items (particularly shop towels) and dust control items (such as floor mats, mops, and tool covers). The remaining items cleaned include linen service items (white uniforms, restaurant and hotel linens, etc.) and a variety of commercial laundry and dry-cleaning products. The major customers of industrial laundries are chemical and manufacturing plants, automotive repair shops and service stations, machine shops, printing establishments, and janitorial services.

Because the nature of this service industry, receipts for the industry are closely tied to the gross national product. The 1982 Census of Service Industries indicates that total receipts of the industrial laundering industry were 1.9 billion dollars in 1982. Linen suppliers (SIC 7213) generated an additional 0.23 billion dollars in receipts for products defined as industrial laundering.

Industrial laundries and linen suppliers use the same basic equipment to provide similar services. Although there is some overlap in the work done by industrial launderers and linen suppliers, industrial launderers rent personalized garments fitted and labeled for the individual while linen suppliers provide rental garments by size. Some industrial laundering is also done, to a lesser extent, by power (commercial) laundries (SIC 7211) and dry cleaners (SIC 7216).

Changes in the industry since the previous EPA studies (1974 and 1979) have not yet been fully documented but some trends are apparent. Factors having relatively great effect on the industry are the cost of energy, and federal, state and local environmental regulations. Increasing energy costs have caused the industry to use lower washwater temperatures whenever possible (7). However, to attain the same degree of cleansing at lower temperatures, the launderer must use greater quantities of surfactants and other chemicals thereby increasing the pollutant loading of the waste effluent.

In many communities, local water pollution control standards have become more strict in recent years causing launderers in these areas to seek methods to reduce their water use and pollutant loadings. Among the solutions occurring in the industry are addition of wastewater pretreatment systems and use of more efficient laundering equipment. Some launderers have dropped customers with particularly dirty garments or shop towels (these customers may send their articles to communities with less stringent regulations). In addition, there appears to be a shift from heavily soiled blue collar work uniforms towards cleaner, white collar work clothes such as the slacks and sports jackets worn by airlines personnel.

More numerous and more stringent water and air standards and concomitant problems of pollutant control are causing the industrial laundries industry to give up dry-cleaning processes in favor of waterwashing processes which result in fewer water pollution and no air pollution problems. In 1977, an estimated 420 facilities out of a total of approximately 1,000 industrial laundries did some dry cleaning. In 1987, there are still approximately 1,000 industrial laundries, but only an estimated 150-160 facilities still use dry-cleaning processes. Further increases in the cost of petrochemicals may further reduce the use of dry-cleaning processes.

3.2 Industry Processes

The three basic processes used at industrial laundries are water wash (laundering), dry cleaning, and dual-phase processing. The process and types of equipment used in each laundry depend to a large degree on the types of services offered.

In the laundering process, soiled materials are first sorted so that processing can be done on the basis of fabric type, color, soil type, ownership, or type of garment. Items requiring prespotting and destaining are identified. Stains which may set as a result of washing must be removed before washing. Destaining procedures include soaking in cold water and use of acids, bleaches, or multiple organic solvents or a combination thereof.

Each laundry load is then put in a washing machine and undergoes a series of cycles in which various processing operations are carried out, depending on the types of items, composition of the fabrics, and the soil classification. The first cycle is generally a flush (defined as any rinsing operation before bleaching) in which water removes loosely attached solids and a portion of the water soluble soils. The flush may be followed by the break (defined as the first supply operation) during which the garments are treated with an alkali solution to swell cellulosic fibers so that soil is more easily removed. Detergents may also be added at the break. The actual wash cycles (sudsing) are multiple procedures in which articles are agitated in repeated changes of detergent solutions until they are clean.

The sudsing cycles are frequently followed by a bleach cycle where the detergent solution is replaced by a bleach solution. Sudsing is then followed by a series of rinsing cycles to reduce the alkali and soap content of the fabrics. Next a blueing or brightening cycle may be included. The final operation (the finish) usually involves souring or acidifying to reduce the pH of the final bath to about 5 to prevent yellowing of fabrics by sodium bicarbonate during pressing.

A typical wash formula for heavily soiled work uniforms is presented in Table 3-1. The number of sudsing operations and rinses and the types of special treatments will vary with the types of materials laundered and with the particular laundry establishment doing the work.

After being laundered, typical fabrics retain water equal in weight to about 2.5 times their dry weight. Most of this water is removed in a 5 to 15-minute cycle in an extractor, which may be either a centrifugelike device or a hydraulic press. When removed from an extractor, fabrics generally retain moisture equivalent to only 50% of their dry weight and are ready for pressing or other finishing operations.

Finishing is the last step before readying the laundry items for customer delivery. Finishing generally refers to drying, pressing, and folding of the laundered goods, but may also

TABLE 3-1

TYPICAL FORMULA FOR HEAVY SOIL (WORK UNIFORMS)[1]

Operation	Washer Water Level	Temp (°F)	Time (Minutes)	Supply Type	pH
Flush	High	140-160	1-3		
Break, Sudsing	Low	180	10-12	Alkali; detergent	11.5-12.5
Sudsing	Low	165-180	5-8	Detergent	
Flush	High	140-160	1-2		
Bleach	Low	140-160	8-10	Bleach	10.2-10.8
Rinse	High	120-140	1-2		
Rinse	High	105-115	1-2		
Rinse	High	105-115	1-2		
Finish	Low	105-115	4-6	Sour; mildistat; Softener	5.5-6.5

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[1] From Textile Laundering Technology (8)

involve destaining and minor repairs. In the past it was the most labor intensiveprocess associated with laundering as each piece was pressed individually. Now, however, much work is being done automatically by steam tunnels. In this process, items on hangers are conveyed through the two chambers of a steam tunnel. Garments are exposed to live steam at about 40 psi. Saturation of each piece with steam heats and relaxes synthetic and natural fibers and the garments return to their original shape. From the steaming section they pass into the drying/air finishing chamber. Here hot dry air is forced over the garments at high velocity so that the wrinkles are removed as the garments are dried. Items that don't require pressing, such as towels, mats, etc., are dried in hot air tumblers.

Conventional washers used in professional laundries can handle loads from 20 to 1,000 pounds and are equipped with thermometers for temperature control, gauges for control of water levels, timing devices, and devices to reverse the direction of rotation every four or five revolutions. The equipment, often fully automatic through the entire wash cycle, usually consists of a perforated horizontal cylinder rotating in a shell. The cylinders are equipped with ribs that lift the fabrics as the cylinder rotates and drops them back into the washing solution. The cylinders range from 24 in. to 60 in. in diameter, and from 18 in. to 126 in. in length. Some washers may automatically deposit the wash load into trucks or an adjacent extractor, but many must be emptied manually at the completion of the washing cycles.

Other washer designs available are the tunnel washer and the modular washer. Tunnel washers provide continuous operation and can process up to 1,870 lb. of laundry per hour in a fully automatic process. Water, steam, and laundry chemicals are mechanically injected into the system, and following washing, the load is moved by conveyer to extractors and dryers. Tunnel washers use a counterflow process: water at tap temperature enters the system at the discharge end for the final rinse and flows through the rinse and suds bath before discharge to a drain. Live steam may be introduced at several points along the tunnel to heat the water to the desired temperature for rinsing, bleaching, and sudsing, or high temperature zones can be located within the tunnel to heat the water. Tunnel washers use less water than conventional washers (0.7 - 1.5 gal/lb of laundry processed versus 1.5 - 5 gal/lb).

Modular units can be used alone or in combination with other units to provide flexibility in machine capacity. These washers have a shell-less design, with agitation provided by a portion of the wash solution surging in and out of the machine. Modular units are loaded from the top by hopper, sling, or conveyor and are unloaded through a front door. The units, when accompanied by conveyors, hydraulic extractors, and tumbler dryers, may constitute a fully automatic system.

Dry-cleaning processes are similar to waterwashing. In the dry-cleaning process, fabrics are cleaned in an organic solvent instead of an aqueous detergent solution. Certain hydrophilic fibers, washed in water, swell and undergo dimensional change that causes wrinkles and shrinkage which can be avoided by use of dry-cleaning solvents. These solvents dissolve soils at low temperatures and under generally mild conditions, unlike laundering processes which involve complex colloidal mechanisms occurring at high temperatures and the use of relatively harsh chemicals such as alkalis and bleaches. Thus, dry-cleaning causes considerably less wear on a fabric than laundering and uses much less water.

The general processing steps for dry cleaning are similar to those for laundering. Three methods are used: charged system, fresh soap added to each load, and no soap added. In the charged system, a detergent and a small quantity of water (usually 0.5% to 4%) are added to the dry-cleaning solvent. The water and detergent concentration in the solvents is maintained throughout the washing process by using conductivity meters to automatically control the addition of water and detergent. In the second method, the solvent is charged with a given amount of soap or detergent at the beginning of each load and does not receive any additional charge during the cleaning cycle. Because the process is not monitored as closely as the charged system, maximum efficiency is not achieved with this system. The no-soap method uses only dry-cleaning solvent.

Standard dry-cleaning equipment consists of a rotating cylinder in a stationary shell and one or more solvent storage tanks, a filter system for cleaning the solvent as it is used, a solvent/water separator, distillation equipment for solvent purification, and often a device for recovering solvent vapors (a condenser or an activated carbon filter). The water separated from the solvent is discharged with other process wastewaters. The wastewater contains varying quantities of the solvent.

Industrial launderers frequently supply customers with dust mops treated with oil the purpose of which is to retain the collected dust. To avoid water pollution problems when the mops are returned for cleaning, some companies clean and treat the mops directly in the treatment oil. Mops are loaded into a washer/extractor and cleaned with the heated treatment oil instead of water. After cleaning, the oil is extracted from the mops leaving them coated with the desired quantity of treatment oil. The dirty oil is then purified by filtration and is reused. This is a closed loop processing system which uses no process water.

Dual-phase or dual-stage processing is a cleaning method that employs a water/ detergent wash and a separate solvent wash to clean items that contain large amounts of both water-soluble soils and oil and grease. The order of processing is determined by the solvent used, type of soil, and drying energy requirements.

All of the 74 industrial laundries for which data were collected in the 1977 data collection portfolio used water-wash for some portion of their workload, 52 dry-cleaned some portion, and 17 used the dual-phase process for some portion. More than 80 percent of the total poundage washed by the surveyed laundries was water-washed, about 13 percent was dry-cleaned, and only about 5 percent was dual-phase processed. Dry cleaning processes are apparently used to a considerably lesser extent at present than in 1977. Relatively high quantities of dry cleaning solvent may enter the wastewater stream as a result of dual-phase cleaning. However, based on discussions with plant personnel and industry association representatives, dual-phase cleaning is being phased out as a laundry process.

SECTION 4

4.0 SUBCATEGORIZATION

The industrial laundries industry is a subcategory of the Auto and Other Laundries point source category. The subcategorization scheme for this category is developed in detail in previous documents (4, 5, 6) and is summarized below.

The primary bases for subcategorization of this category were type of items cleaned, nature and quantity of soils and contaminants present on the items, and cleaning processes used. The subcategorization scheme consists of nine separate subcategories of which only the industrial laundries subcategory is currently being studied in this report. This study does not propose any major modifications to the subcategorization scheme, but there are two significantly different processes used in the industrial laundries subcategory that were not fully considered in earlier studies: laundering shop towels and dry cleaning.

4.1 Laundering Shop Towels

The subdivision of the industrial laundries subcategory into two product sectors, shop towels and all other water washed items, was not suggested at the time of the subcategorization development. However, the data suggest that pollutant loading for shop towel wastewaters is so much higher than the combined wastewaters from other water washed products that significant reductions in pollutant loads can be realized by treating only wastewater from shop towel washing processes.

According to the 1977 data collection survey, most industrial laundries wash some shop towels, but very few wash only shop towels. A substantial portion, about 20 percent, of the industry's total production is shop towels. It is therefore probably not practical to create a new subcategory for towel washing, but it should be considered a significant product sector of the industry.

There is general recognition within the industry that the greatest single source of pollutants of concern is from laundering shop towels which are also referred to as wipers or rags. This has been supported in conversations with laundry personnel, permitting authorities, and treatment system operators. EPA has on record several letters from treatment system operators stating that wastewater from industrial laundries and specifically wastewater from laundering shop towels, are among their major problems. A number of laundries have reduced their pollutant loads by refusing to service some customers' shop towels or by segregating the wastewater from their towel washing processes and treating this wastewater apart from the rest.

Shop towels are used to clean solvents or soils from various objects or to wipe up spilled solvents and other liquids until they are saturated. They are designed to absorb as much liquid as possible. Shop towels are commonly used in print shops, machine shops, and automotive repair shops. They frequently contain large quantities of toxic volatile organic solvents such as toluene, ethyl benzene, or tetrachloroethene; semivolatile organics such as isophorone and naphthalene; and toxic metals such as lead and chromium. They may also contain nonconventional volatile pollutants such as acetone and methyl ethyl ketone as well as nonvolatile long-chain alkane compounds. Since shop towels contain heavy soils loads, they require more water and laundry chemicals per pound washed than do other laundered items. Thus, the pollutant loads from towel washing processes are further increased.

There have been very little analytical data available for estimating pollutant loads resulting from laundering shop towels versus laundering other articles. During the current study, one laundry was sampled that segregates towel washing wastewater from other process wastewaters. The pollutant concentrations for the segregated towel washing wastewater stream, and for the remaining wastewater from washing uniforms and all other products are presented in Table 5-12 in the next section.

To obtain a comparison of pollutant loads between washing shop towels and washing uniforms and all other products, the data shown in Table 5-12 have been converted to average pounds of pollutant per 1000 pounds of product laundered. These average pollutant loads have been summed over each of the following groups: volatile organic compounds, semi-volatile organic compounds, priority pollutant metals, common metals (Ca, Fe, Mg, Na), and other metals (Al, Ba, B, Co, Mn, Mb, Sn, Ti, V, Y). These total loads and the loads for BOD_5, COD, TSS, and oil and grease are presented in Table 4-1.

Although the data are based on only two days sampling of wastewater streams which contain highly variable quantities of pollutants, the difference in the average pollutant loads per 1000 pounds product between shop towels and uniforms is pronounced. The pollutant loads resulting from washing towels contain four to nine times as much priority pollutant metals, common metals, and other metals, BOD_5, TSS, and COD as the pollutant loads resulting from washing uniforms. Laundering towels generates approximately 35 times as much semi-volatile organics, 32 times as much oil and grease, and 100 times as much volatile organics. Although the amount of data is limited, the data do indicate that the difference between pollutant loads generated by laundering towels and laundering other products is significant.

4.2 Dry Cleaning

Dry cleaning is another process used in the industrial laundries industry that was not proposed for further consideration during earlier studies. Dry cleaning is recognized as a separate subcategory that is defined as comprising facilities producing a product for the general public. Industrial launderers who use some dry-cleaning processes, or only dry cleaning processes and

TABLE 4-1

RAW WASTEWATER POLLUTANT LOADING: COMPARISON BETWEEN LAUNDERING SHOP TOWELS AND LAUNDERING UNIFORMS

Pollutant	Average Raw Waste[1] Shop Towels (Pounds per 1000 pounds towels)	Average Raw Waste[1] Uniforms (Pounds per 1000 pound uniforms)	Ratio[1] of Towels Raw Waste: Uniforms Raw Waste
total volatile organic compounds[2]	1.49	0.014	106
total semi-volatile organic compounds[2]	1.11	0.032	35
total pesticides and herbicides[2]			
total priority pollutant metals[2]	0.718	0.154	4.7
total common metals[3]	16.6	3.55	4.7
total other metals[4]	0.420	0.115	3.7
BOD_5	46.3	8.29	5.6
COD	188	47.3	4.0
total suspended solids	78.6	9.14	8.6
oil and grease	113	3.58	32
flow (gal/lb production)	2.1	1.7	1.2

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[1] These estimates are based on average concentrations and productions during a two-day sampling episode and long-term average flow rates.

[2] See Table 5-12 for listing of specific pollutants.

[3] Ca, Fe, Mg, Na

[4] Al, Ba, B, Co, Mn, Mb, Sn, Ti, V, Y

no waterwashing processes, are considered to be in the industrial laundry subcategory.

The most commonly used dry-cleaning solvent, tetrachloroethene, also known as perchloroethylene or perc, is a chlorinated hydrocarbon and therefore a pollutant of concern. The dry-cleaning processes contribute some perc to the wastewater stream, but there is little data available to quantify a relationship between the amount of dry-cleaning processed at an industrial laundry and the pollutant loading resulting therefrom. Dry-cleaning processes also generate much less wastewater than other laundering processes. Few industrial laundries employ only dry-cleaning processes and most industrial laundries that do some dry cleaning are using the dry-cleaning processes less than in the past. Therefore, at present, there is little evidence suggesting a need for subdivision of the industrial laundries subcategory with respect to dry-cleaning processes.

SECTION 5

5.0 WATER USE AND WASTE CHARACTERIZATION

In this section the quantity of wastewater discharged and the types and concentrations of pollutants found in the wastewater and waste solids generated by the industrial laundry industry are discussed. In the ensuing discussions the pollutants or pollutant parameters have been divided into four groups which have the following specific definitions.

- Conventional Pollutants - The conventional pollutants include biological oxygen demand (BOD_5), nonfilterable residue (TSS), pH, and oil and grease.
- Priority Pollutants - The 126 toxic pollutants listed by the Agency as a condition of the NRDC Consent Decree.
- Nonconventional Pollutants - This group comprises the pollutants on EPA's "1987 List of Analytes" which are not conventional or priority pollutants, or parameters for characterizing solid waste (solid waste characteristics). The group consists of the organic (including pesticides and herbicides), metallic and elemental pollutants and traditional pollutants mostly analyzed by wet chemistry methods including filterable residue, fluoride, ammonia, Kjeldahl nitrogen, nitrate-nitrite, phosphorus, chemical oxygen demand (COD), total organic carbon (TOC), and sulfide.
- Solid Waste Characteristics - These pollutant parameters, used only to characterize solid wastes, are flash point, pH (soil), total residue, total volatile residue, total sulfide, reactivity, toxicity, and corrosivity.

The priority and nonconventional pollutant groups are further divided into the following subgroups which are based, in part, on the analytical methods used to detect their presence.

- volatile organic compounds
- semivolatile organic compounds
- pesticides and herbicides
- miscellaneous priority pollutants (cyanide)
- metals and elements
- miscellaneous nonconventional pollutants (COD and common ions)

5.1 Water Use Characterization

In typical industrial laundries, the principle sources of wastewater are from waterwashing laundering processes, plant and equipment cleaning, and sanitary water. Dual-phase laundering and dry cleaning are minor sources of process wastewater: the former is rarely used and the latter consumes only small quantities of process water.

The volume of washwater used in industrial laundries ranges from 0.9 to 9.6 gal/lb of material washed and averages 4.8 gal/lb. The total volume of washwater ranges from 8,600 to 290,000 gpd and averages 68,000 gpd per facility. In general, only incoming water is monitored, but it is estimated that 70-85% of the total water metered into a plant is discharged as process wastewater. Eight to ten percent of the incoming water is evaporated from laundered textiles during the drying cycles and approximately 10 percent is used for sanitary or cleaning purposes. A laundry using dry cleaning processes may discharge noncontact cooling water.

Both the average quantity of process wastewater discharged and the instantaneous rate of discharge at each establishment are highly variable. The quantity of water discharged depends on the efficiency of the equipment and operations, water conservation measures applied, types of articles cleaned, types and loadings of soils on the articles, and the total amount of waterwashing versus dry cleaning at each laundry. Wastewater discharge rates and pollutant loadings vary with time. Typical laundries have four to eight washers operating independently, discharging quantities of water that are a function of the loads washed.

5.2 Wastewater Characteristics

In this section the raw wastewater effluent from industrial laundries will be characterized in terms of conventional, priority, and nonconventional pollutant parameters. Tables in the next section list the pollutant parameters searched for, a brief discussion of the sources of pollutants found in the wastewater and a presentation of the pollutants found during this and previous studies of the industry.

5.2.1 Pollutants Searched For

In the past, industrial laundries wastewaters have been characterized by the following conventional, nonconventional, and priority pollutant parameters.

- pH
- 5-day biochemical oxygen demand (BOD_5)
- chemical oxygen demand (COD)
- total organic carbon (TOC)
- non-filterable residue or total suspended solids (TSS)
- oil and grease
- phosphorus
- 126 priority pollutants

This study characterizes industrial laundry wastewater using these same pollutant parameters as well as approximately 250 additional volatile and semivolatile organic pollutants derived from the "ITD/RCRA List of Lists" and an extended list of metallic and elemental and miscellaneous nonconventional pollutants. The entire list of pollutants analyzed for during the current ITD/RCRA study constitutes "The 1987 ITD List of Analytes". Table 5-1 presents a list of priority pollutants, and

Table 5-2 presents the remainder of the 1987 ITD List of Analytes.

TABLE 5.1

LIST OF PRIORITY POLLUTANTS ANALYZED IN THE WASTEWATER OF LAUNDRIES A,B,C, and D.

I. METALS

ANTIMONY
ARSENIC
BERYLLIUM
CADMIUM
CHROMIUM
COPPER
LEAD
MERCURY
NICKEL
SELENIUM
SILVER
THALLIUM
ZINC

II. MISCELLANEOUS

ASBESTOS *
CYANIDES

III. DIBENZO-P-DIOXINS AND DIBENZOFURANS

2,3,7,8-TCDD

IV. PURGEABLE

1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3-DICHLOROPROPYLENE
2-CHLOROETHYL VINYL ETHER
ACROLEIN
ACRYLONITRILE
BENZENE
BROMOFORM
BROMODICHLOROMETHANE
BROMOMETHANE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
DIBROMOCHLOROMETHANE
ETHYL BENZENE
METHYLENE CHLORIDE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRICHLOROETHENE
VINYL CHLORIDE

V. EXTRACTABLE

A. PESTICIDES

1. ORGANOHALIDE

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
GAMMA-BHC
HEPTACHLOR
HEPTACHLOR EPOXIDE
PCB-1016
PCB-1221
PCB-1232
PCB-1242
PCB-1248
PCB-1254
PCB-1260
TOXAPHENE

B. SEMI-VOLATILES

1. ACIDS

2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2-CHLOROPHENOL
2-NITROPHENOL
4-NITROPHENOL
DINITROCRESOL
PENTACHLOROPHENOL
PHENOL

2. BASES

1,2-DIPHENYLHYDRAZINE
2,4-DINITROTOLUENE
2,6-DINITROTOLUENE
3,3-DICHLOROBENZIDINE
4-BROMOPHENYL PHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROPHENYL PHENYL ETHER
BENZIDINE
bis(2-CHLOROETHYL)ETHER
bis(2-CHLOROISOPROPYL)ETHER

B. SEMI-VOLATILES

2. BASES

DI-N-PROPYLNITROSAMINE
FLUORENE
ISOPHORONE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
NITROBENZENE
PYRENE

3. NEUTRALS

a. PHTHALATES

BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIETHYL PHTHALATE
DIMETHYL PHTHALATE

b. POLYNUCLEAR AROMATIC

2-CHLORONAPHTHALENE
ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(GHI)PERYLENE
BENZO(K)FLUORANTHENE
CHRYSENE
DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE

c. CHLORINATED HYDROCARBONS

1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
bis(2-CHLOROETHOXY)METHANE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE

* NOT ANALYZED FOR

TABLE 5.2

LIST OF NON-PRIORITY POLLUTANT PARAMETERS ANALYZED IN WASTEWATER OF LAUNDRIES A,B,C, and D

I. ELEMENTS

ALUMINUM
BARIUM
BISMUTH
BORON
CALCIUM
CERIUM
COBALT
DYSPROSIUM
ERBIUM
EUROPIUM
GADOLINIUM
GALLIUM
GERMANIUM
GOLD
HAFNIUM
HOLMIUM
INDIUM
IODINE
IRIDIUM
IRON
LANTHANUM
LITHIUM
LUTETIUM
MAGNESIUM
MANGANESE
MOLYBDENUM
NEODYMIUM
NIOBIUM
OSMIUM
PALLADIUM
PHOSPHORUS
PLATINUM
POTASSIUM
PRASEODYMIUM
RHENIUM
RHODIUM
RUTHENIUM
SAMARIUM
SCANDIUM
SILICON
SODIUM
STRONTIUM
SULFUR
TANTALUM
TELLURIUM
TERBIUM
THORIUM
THULIUM
TIN
TITANIUM
TUNGSTEN
URANIUM
VANADIUM
YTTERBIUM
YTTRIUM
ZIRCONIUM

II. MISCELLANEOUS

RESIDUE, FILTERABLE
RESIDUE, NON-FILTERABLE
AMMONIA, AS N
NITROGEN, KJELDAHL, TOTAL
TOTAL PHOSPHORUS

II. MISCELLANEOUS

BOD-5
COD
OIL & GREASE, TOTAL RECOVERABLE
TOTAL ORGANIC CARBON
FLASH POINT
PH, SOIL
CORROSIVITY
FLUORIDE
NITRATE/NITRITE
SULFIDE

III. DIBENZO-P-DIOXINS AND DIBENZOFURANS

DIBENZOFURAN
HEPTACHLORODIBENZO-P-DIOXINS
HEPTACHLORODIBENZOFURANS
HEXACHLORODIBENZO-P-DIOXINS
HEXACHLORODIBENZOFURANS
OCTACHLORODIBENZO-P-DIOXINS
OCTACHLORODIBENZOFURANS
PENTACHLORODIBENZO-P-DIOXINS
PENTACHLORODIBENZOFURANS
TETRACHLORODIBENZO-P-DIOXINS
TETRACHLORODIBENZOFURANS

IV. PURGEABLE

1.1.1.2-TETRACHLOROETHANE
1.2.3-TRICHLOROPROPANE
1.2-DIBROMOETHANE
1.3-DICHLOROPROPANE
1.3-DICHLORO-2-PROPANOL
1.4-DIOXANE
1-BROMO-2-CHLOROBENZENE
1-BROMO-3-CHLOROBENZENE
2-BUTENAL
2-HEXANONE
2-PICOLINE
3-CHLOROPROPENE
4-METHYL-2-PENTANONE
ACETONE
ALLYL ALCOHOL
CARBON DISULFIDE
CHLOROPRENE
CIS-1.3-DICHLOROPROPENE
DIBROMOCHLOROPROPANE
DIBROMOMETHANE
DICHLOROFLUOROMETHANE
DIETHYL ETHER
DIMETHYL SULFONE
ETHYL CYANIDE
[illegible] METHACRYLATE
ISOBUTYL ALCOHOL
METHACRYLONITRILE
METHYL ETHYL KETONE
METHYL IODIDE
METHYL METHACRYLATE
N.N-DIMETHYLFORMAMIDE
TRANS-1.3-DICHLOROPROPENE
TRANS-1.4-DICHLORO-2-BUTENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE

V. EXTRACTABLE

A. PESTICIDES

1. ORGANOHALIDE

CAPTAFOL
CAPTAN
CHLOROBENZILATE
ENDRIN KETONE
ISODRIN
KEPONE
METHOXYCHLOR
MIREX
NITROFEN
PCNB

2. CARBAMATES

ETHYLENEBISDITHIOCARBAMIC ACID,SALTS, AND ESTERS
MANEB
NABAM
THIRAM
ZINEB
ZIRAM

3. ORGANOPHOSPHORUS

AZINPHOS-ETHYL
AZINPHOS-METHYL
CARBOPHENOTHION
CHLORFENVINPHOS
CHLORPYRIFOS
COUMAPHOS
CROTOXYPHOS
CYGON
DEMETON
DIAZINON
DICHLORVOS
DICROTOPHOS
DIOXATHION
DISULFOTON
EPN
ETHION
FAMPHUR
FENSULFOTHION
FENTHION
HEXAMETHYLPHOSPHORAMIDE
LEPTOPHOS
MALATHION
METHYL PARATHION
MEVINPHOS
MONOCROTOPHOS
NALED
PARATHION ETHYL
PHORATE
PHOSMET
PHOSPHAMIDON
SULFOTEPP
TEPP
TERBUFOS
TETRACHLORVINPHOS
TRICHLOROFON
TRICRESYLPHOSPHATE
TRIMETHYLPHOSPHATE

TABLE 5.2 (continued)

LIST OF NON-PRIORITY POLLUTANT PARAMETERS ANALYZED IN WASTEWATER OF LAUNDRIES A,B,C, and D

4. HERBICIDES

2,4-D
2,4,5-T
2,4,5-TP
DIALLATE
DICHLONE
DINOSEB
TRIFLURALIN

B. SEMI-VOLATILES

1. ACIDS

2.3.4.6-TETRACHLOROPHENOL
2.3.6-TRICHLOROPHENOL
2.4.5-TRICHLOROPHENOL
2.6-DICHLOROPHENOL
BENZOIC ACID
CARBAZOLE
HEXANOIC ACID
MALACHITE GREEN
O-CRESOL
P-CRESOL
P-CYMENE
PHENACETIN
THIOPHENOL

2. BASES

1.3-DICHLORO-2-PROPANOL
1.3.5-TRITHIANE
1.4-DINITROBENZENE
1.4-NAPHTHOQUINONE
1.5-NAPHTHALENEDIAMINE
1-CHLORO-3-NITROBENZENE
1-METHYLFLUORENE
1-METHYLPHENANTHRENE
1-NAPHTHYLAMINE
1-PHENYLNAPHTHALENE
2.3-DICHLOROANILINE
2.3-DICHLORONITROBENZENE
2.3-BENZOFLUORENE
2.4.5-TRIMETHYLANILINE
2.4-DIAMINOTOLUENE
2.6-DI-TERT-BUTYL-P-BENZOQUINONE
2-ISOPROPYLNAPHTHALENE
2-(METHYLTHIO)BENZOTHIAZOLE
2-METHYLBENZOTHIOAZOLE
2-METHYLNAPHTHALENE
2-NAPHTHYLAMINE
2-NITROANILINE
2-PHENYLNAPHTHALENE
3.3-DIMETHOXYBENZIDINE
3.6-DIMETHYLPHENANTHRENE
3-METHYLCHOLANTHRENE
3-NITROANILINE
4.4'-METHYLENEbis(2-CHLOROANILIN
4.5-METHYLENE PHENANTHRENE
4-AMINOBIPHENYL
4-CHLORO-2-NITROANILINE
4-NITROBIPHENYL
5-CHLORO-O-TOLUIDINE
5-NITRO-O-TOLUIDINE
7.12-DIMETHYLBENZ(a)ANTHRACENE
ACETOPHENONE
ANILINE
ARAMITE
BENZANTHRONE
BENZYL ALCOHOL
bis(CHLOROMETHYL)ETHER

B. SEMI-VOLATILES

2. BASES

BROMOXYNIL
CHLOROACETONITRILE
DICHLORAN
DIBENZOTHIOPHENE
DIPHENYL ETHER
DIPHENYLAMINE
ERYTHRITOL ANHYDRIDE
MESTRANOL
METHAPYRILENE
METHYL METHANESULFONATE
N.N-DIMETHYLFORMAMIDE
N-NITROSODI-N-BUTYLAMINE
N-NITROSODIETHYLAMINE
N-NITROSOMETHYLPHENYLAMINE
N-NITROSOMETHYLETHYLAMINE
N-NITROSOMORPHOLINE
N-NITROSOPIPERIDINE
O-ANISIDINE
O-TOLUIDINE
P-CHLOROANILINE
P-DIMETHYLAMINOAZOBENZENE
P-NITROANILINE
PHENOTHIAZINE
PRONAMIDE
PYRIDINE
THIANAPHTHENE
TRIPHENYLENE
TRIPROPYLENEGLYCOL METHYL ETHER

3. N-ALKANES

N-DECANE
N-DOCOSANE
N-DODECANE
N-EICOSANE
N-HEXACOSANE
N-HEXADECANE
N-OCTACOSANE
N-OCTADECANE
N-TETRACOSANE
N-TETRADECANE
N-TRIACONTANE

4. OTHERS

1.2.3-TRICHLOROBENZENE
1.2.3-TRIMETHOXYBENZENE
1.2.4.5-TETRACHLOROBENZENE
ALPHA-TERPINEOL
BIPHENYL
DIPHENYL SULFIDE
ETHYLENETHIOUREA
ETHYLMETHANE SULFONATE
HEXACHLOROPROPENE
ISOSAFROLE
LONGIFOLENE
PENTACHLOROBENZENE
PENTACHLOROETHANE
PENTAMETHYLBENZENE
PERYLENE
RESORCINOL
SAFROLE
SQUALENE
STYRENE
THIOACETAMIDE
THIOXANTHONE

5.2.2 Pollutant Sources

The characteristics of laundry wastewaters are primarily determined by three factors: the general type of cleaning process employed (i.e., water versus solvent wash), the types and quantity of soil present on the textiles being laundered, and the composition of the various laundering chemicals used.

Cleaning Processes Used - Water-wash effluents contain all of the soil and lint removed from the textiles, as well as the laundry chemicals employed in the process. Wastewaters from dry-cleaning processes tend to contain mostly water-soluble materials and appreciable quantities of dry cleaning solvent, the latter normally not present in water-wash effluents. Lint, grit, and water-insoluble organic and inorganic compounds are largely removed by the solvent filter or confined to the still bottoms.

Soils Present on Textiles - The soils present in the textiles brought to each laundry for cleaning vary greatly in composition and in quantity, reflecting the types of customers serviced by each laundry. The greatest single source of hazardous pollutants is probably shop towels and wiping rags which are apparently used by some customers to dispose of considerable quantities of organic solvents. The towels and wipers may contain soils amounting to more than 50 percent of their dry weight. Soils contained on garments and other articles laundered reflect the work environments of the industrial manufacturers, chemical manufacturers, service industries and others that constitute the clientele of industrial launderers. Mats, dust mops, and other cleaning articles contribute a great deal of sand and grit to the pollutant load but probably no more hazardous pollutants than are found in the general environment.

Laundering Chemicals - The process chemicals used in laundering, i.e., the laundry formulae, also contribute substantially to the pollutant load although they may be of lesser importance than the soil loading. The soaps and detergents contribute to the BOD_5 and oil and grease loadings. Laundry wastewaters generally have a high pH as most laundering processes occur under alkaline conditions. A number of priority and other hazardous pollutants are used for a variety of purposes. Zinc compounds are used in sours and germicides. Phenolic compounds are used in germicides, bacteriostats, dust treating compounds, and detergent additives. Various solvents are used for spot removal and oils may be used to clean dust mops. Effluents from laundries using chlorine bleaches probably contain chlorinated hydrocarbons produced during the bleaching process.

5.2.3 Wastewater Analytical Data

Wastewater analytical data have been obtained from a variety of sources during earlier EPA studies of the industrial laundries industry. The first EPA study, initiated in 1971, included a survey sent to 160 plants. These plants were all members of the Institute of Industrial Launderers or the Linen Supply Association of America (LSAA, now the Textile Rental Services

Association of America) and included industrial laundries, linen services and diaper services. In addition to wastewater analytical data obtained from the survey, EPA obtained extensive sampling data for conventional and nonconventional pollutants and some metals at a small number of plants. These studies resulted in two EPA documents in 1974: a Draft Development Document for Proposed Effluent Limitations Guidelines (2), and the Modular Wastewater Treatment System Demonstration (3).

During studies of the Auto and Other Laundries Category taking place between 1975 and 1978, EPA gathered conventional, nonconventional, and priority pollutant analytical data for the industrial laundries subcategory from several major sources. In 1977 EPA sent surveys to a number of facilities in the category and received responses from approximately 70 industrial laundries. The survey provided little wastewater analytical data, but was the major source of production and process information used in these studies. The 1977 survey is still the principal source of water usage information available.

Conventional and nonconventional pollutant data and some priority pollutant metals data were obtained from municipal sewer district monitoring reports. These where obtained for industrial laundries within the jurisdictions of the Metropolitan Sanitary District of Greater Chicago, County Sanitation District of Los Angeles County, and the Dade County (Florida) Sanitation District.

In 1977 and 1978 the LSAA sponsored a survey of 20 member facilities. Mostly linen supply plants were sampled but some data were obtained from industrial laundries. The study was focused primarily on conventional and nonconventional pollutants and some common priority pollutant metals. The data were summarized in a 1978 "Report of 20 Member Plants," (39).

Additional wastewater analytical data were obtained from published and unpublished literature sources (3, 35, 36, 37, 38). These data also consisted primarily of conventional and nonconventional and common priority pollutant metals.

In 1978, EPA undertook a screening and verification analysis program for the Auto and Other Laundries Point Source Category, to obtain conventional and nonconventional pollutant data, and data for the entire list of 126 priority pollutants including metals and organics. Analytical wastewater data were obtained during this program for approximately 14 industrial laundries. Most of the laundries sampled had wastewater pretreatment systems in place and influent and effluent data were obtained from these plants to characterize the efficiency of the treatment systems. Most of the sampling episodes were of one day duration, but a plant with a dissolved air flotation system was sampled for 30 days to obtain variability data.

The screening and verification study was the principle source of organic priority pollutant data although additional organic priority pollutant data were obtained from another EPA study.

Data from seven laundries were obtained for a 1977 EPA study, the results of which were published in a document entitled The Occurrence and Treatability of Priority Pollutants in Industrial Laundry Wastewaters (37).

Summaries of the conventional and nonconventional pollutant concentrations found in laundries wastewaters during the 1975-78 data gathering efforts and sampling programs are presented in Table 5-3; summaries of priority pollutant concentration data gathered during the screening and verification program are presented in Table 5-4. For reference, the concentrations of some conventional and nonconventional pollutants in domestic sewage are presented in Table 5-5.

5.3 Wastewater Sampling and Analysis

During the ITD/RCRA industry study, screening sampling episodes were undertaken at four industrial laundries. Another laundry was sampled in 1985 as part of the Domestic Sewage Study. This laundry and the analytical data from it are included in the discussion which follows. Three of the laundries are located in two large midwestern cities, one in a moderate sized southeastern city and one in a moderate sized northeastern city. Laundries A and B treat their effluent using dissolved air flotation systems, and Laundries C and E use only settling basins with short detention time. Laundry D has split wastewater streams: the effluent from two washers dedicated to shop towels is treated using an ultrafiltration system and the effluent from all other laundering processes is discharged through two settling basins with short detention times.

During the most recent sampling program, wastewater samples were obtained from raw waste streams and final effluent streams at four laundries. At the fifth laundry (Laundry E), samples were obtained of the final effluent after a settling basin. In addition, wastewater samples were obtained at several intermediate points at the laundry with ultrafiltration (Laundry D) to generate treatment efficiency data across the ultrafilter and across ancillary lint screens. The wastewater samples were analyzed for conventional pollutants, priority pollutants, and nonconventional pollutants, including approximately 250 non-priority organic compounds from the ITD List of Analytes[1] (see Tables 5-1 and 5-2). The analytical methods used to detect the pollutants are listed in Appendix A.

Each of the four sampling episodes in which influent and effluent samples were obtained consisted of two consecutive, separate, complete wastewater discharge periods (each working day was approximately ten hours in duration). The fifth sampling episode

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[1] The list of pollutants searched for in the samples from Laundry E differs slightly from the list presented in Tables 5-1 and 5-2. The analytes searched for at Laundry E can be found in Appendix B.

TABLE 5-3

CONVENTIONAL AND NONCONVENTIONAL POLLUTANT CONCENTRATIONS IN INDUSTRIAL LAUNDRY WASTEWATERS[1]

Pollutant	Number of Samples	Minimum Concentration (mg/ℓ)	Maximum Concentration (mg/ℓ)	Median Concentration (mg/ℓ)	Average Concentration (mg/ℓ)
pH (standard units)	62	7.5	11.9	10.5	10.4
BOD_5	51	91	7,800	920	1,300
COD	60	330	7,000	3,800	5,000
TOC	24	130	6,800	1,200	1,400
TSS	69	68	6,100	700	1,000
oil and grease	66	17	7,900	730	1,000
phosphorus	12	1.3	41.6	9.1	12.2

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[1] See Reference (6), p.35. Data were obtained from 73 plants in 1975.

TABLE 5-4

PRIORITY POLLUTANT CONCENTRATIONS IN INDUSTRIAL LAUNDRY RAW WASTEWATERS[1]

Pollutant Category and Pollutant	Number[2]	Maximum Concentration (mg/ℓ)	Median Concentration[3] (mg/ℓ)	Average Concentration[3] (mg/ℓ)
Metals				
antimony	7/8	2.4	0.11	0.384
arsenic	6/6	0.025	0.011	0.013
cadmium	7/7	0.11	0.060	0.059
chromium	8/8	1.2	0.47	0.564
copper	8/8	4.0	1.54	1.67
lead	8/8	9.4	4.6	5.12
mercury	4/5	0.002	0.0015	0.0013
nickel	8/8	0.46	0.12	0.176
selenium	0/4	0.0	0.0	0.0
silver	2/4	0.117	0.004	0.031
zinc	8/8	4.5	2.99	3.16
Volatile Organic Compounds				
benzene	2/6	0.13		0.022
carbon tetrachloride	2/6	0.85		0.142
1,1,1-trichloroethane	2/6	3.3		0.553
chloroform	4/6	0.035	0.002	0.008
ethylbenzene	5/6	17.5	0.142	3.13
methylene chloride	3/6	0.54	0.001	0.109
dichlorobromomethane	1/6	0.003		0.0005
tetrachloroethene	5/6	0.88	0.044	0.219
toluene	5/6	2.6	0.56	1.02
trichloroethylene	2/6	0.80		0.036
Semi-volatile Organic Compounds				
2-chloronaphthalene	1/6	0.017		0.003
dichlorobenzenes	1/6	1.1		0.183
2,4-dimethylphenol	1/6	0.46		0.077
isophorone	1/6	0.19		0.032
naphthalene	4/6	4.8	0.217	1.54
N-nitrosodiphenylamine	1/6	1.8		0.300
phenol	4/6	0.60	0.059	0.136
bis(2-ethylhexyl) phthalate	4/6	3.1	0.66	1.17
butyl benzyl phthalate	2/6	1.5		0.301
di-n-butyl phthalate	3/6	0.66	0.046	0.175
di-n-octyl phthalate	2/6	0.41		0.093
anthracene/phenanthrene	3/6	0.47	0.004	0.143
Cyanide				
cyanide	4/5	0.28	0.057	0.121

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[1] Data are from 1978 screening program. See 1982 Guidance Document (6), Section 5 and Appendix A. Data presented here are average influent concentrations at Plants A,B,C,D,E,K,L, and Z.

[2] Ratio indicates the number of samples in which the specific pollutant was found as compared to the total number of samples analyzed.

[3] Blanks indicate values below analytical detection limits.

TABLE 5-5

CONVENTIONAL AND NONCONVENTIONAL POLLUTANT CONCENTRATIONS IN DOMESTIC SEWAGE[1]

Pollutant	Typical Concentration Range, mg/l
BOD_5	100-300
COD	250-1,000
TOC	100-300
TSS	100-350
oil and grease	50-150
phosphorus	6-20

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[1] See Reference (6), p.35

consisted of one working day of 24 hours duration. Wastewater oursamples were composites of samples taken during the entire work day.

5.4 Waste Solids Sampling and Analysis

In addition to wastewater samples, samples of waste solids generated in the various wastewater treatment technologies in use were also obtained during the recent sampling episodes at the four laundries at which both raw waste and final effluent samples were taken. Samples were obtained of thickened DAF sludge, of sediments from settling basins, and of solids from two lint screens at one of the laundries. In addition to solids samples, an oil sample from an oil skimmer and a final concentrate sample from an ultrafiltration unit were obtained.

Solids samples (including oil and concentrate samples) were one-time grab samples taken once during each episode. These samples were analyzed for the same pollutants as the wastewater samples except that wet chemistry analyses were not performed on the oil and concentrate samples. In addition, the solids (but not the oil or concentrate samples) were analyzed for the following solid wastes characteristics: flash point; soil pH; total residue; total volatile residue; and total sulfide.

To estimate the leaching hazards posed by the soils-type of solid wastes, the toxicity criteria leachate procedure (TCLP) was applied to these solids. The extracts obtained from the soils by TCLP were analyzed for all the pollutants on the ITD list (except TCLP extracts were not analyzed for herbicides and pesticides at Laundries A and B).

5.5 Sampling and Analytical Results

The results of the analyses of the raw waste and final effluent streams at the five laundries sampled during the current ITD/RCRA study are summarized in Tables 5-6 through 5-12. Schematics of the waste treatment systems employed by each laundry are presented in Figure 5-1 with all of the sample points indicated on the schematic. Each table contains all the pollutants detected at a single laundry and the concentration levels at which they were detected in each wastewater stream and solids sample. Tables 5-6, 5-7, 5-8, and 5-12 contain the results of analyses of all wastewater streams and solids samples obtained at Laundries A, B, C, and E respectively. Table 5-9 contains the results of analyses of water and wastewater samples at Laundry D. Table 5-10 contains the results of analyses of solids and oils samples at Laundry D. Table 5-11 presents the flow weighted average raw waste pollutant concentrations for the combined wastewater streams at Laundry D.

5.6 Analytical Data from Other Sources

Extensive monitoring data for industrial laundries exist, as many POTWs enforce some discharge standards or at least require some monitoring. Almost all standards and consequently monitoring, however, are for some conventional and a few nonconventional

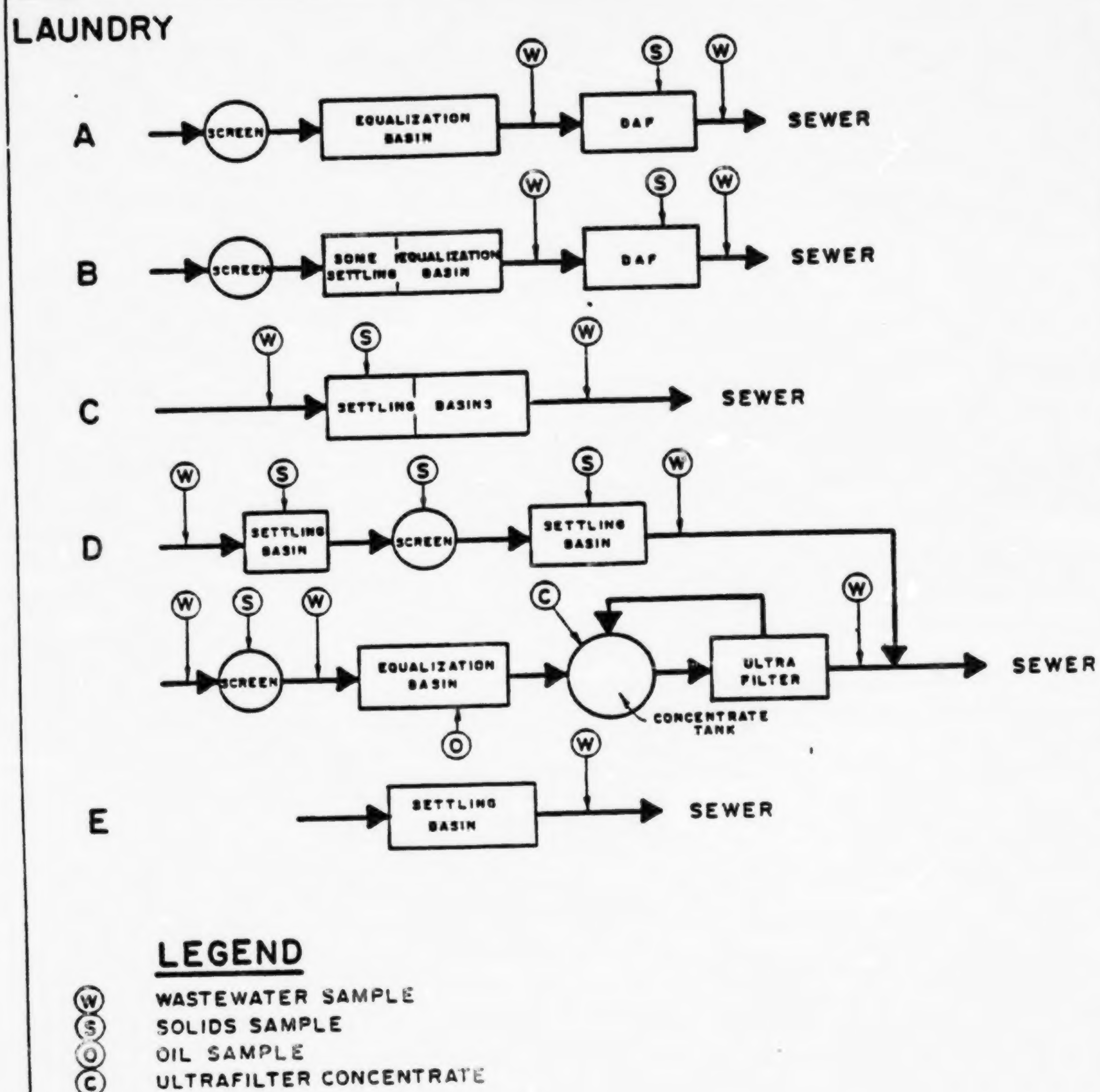
LAUNDRY
A
SCREEN
EQUALIZATION BASIN
DAF
SEWER
B
SCREEN
SOME SETTLING
EQUALIZATION BASIN
DAF
SEWER
C
SETTLING BASINS
SEWER
D
SETTLING BASIN
SCREEN
SETTLING BASIN
SCREEN
EQUALIZATION BASIN
ULTRA FILTER
CONCENTRATE TANK
SEWER
E
SETTLING BASIN
SEWER
W
S
O
C
LEGEND
W WASTEWATER SAMPLE
S SOLIDS SAMPLE
O OIL SAMPLE
C ULTRAFILTER CONCENTRATE

FIGURE 5-1
SUMMARY OF TREATMENT
SYSTEMS AND SAMPLING POINTS
ITD/RCRA SAMPLING PROGRAM

TABLE 5-6
SUMMARY OF REPORTED ANALYTICAL RESULTS
LAUNDRY A

Pollutant Category and Pollutant	Wastewater (μg/ℓ)				Solids	
	Raw Wastewater		Treated Wastewater		Thickened Sludge (μg/kg)	TCLP[1] Extract (μg/ℓ)
	Day 1	Day 2	Day 1	Day 2		
Volatile Organic Compounds						
toluene*	10,292	1,780	2,032	1,967	4,831	116
1,1,1-trichloroethane*	--	--	--	--	369	--
methylene chloride*	--	41	--	--	--	--
ethyl benzene*	12,396	1,304	2,574	--	2,569	912
acetone	15,831	1,373,430	--	--	--	--
Semi-volatile Organic Compounds						
biphenyl	1,766	--	--	--	79	--
butyl benzyl phthalate*	--	--	--	--	397	--
di-n-butyl phthalate*	--	--	--	--	497	--
isophorone*	--	--	4,212	3,033	--	--
n-decane	--	3,481	--	--	--	--
n-docosane	6,391	--	--	3,106	--	--
n-dodecane	3,362	2,141	2,207	3,205	--	33
n-eicosane	--	--	--	--	--	48
N-nitrosodi-n-propylamine*	14,945	3,773	--	3,204	--	--
n-tetracosane	8,351	1,379	3,797	7,399	--	--
n-tetradecane	18,615	11,212	--	5,571	--	35
naphthalene*	--	12,963	--	6,628	179	93
p-cymene	3,464	--	--	--	--	--
2-chloronaphthalene*	--	--	7,491	--	114	56
4-chloro-3-methylphenol*	--	--	65	--	--	--
alpha-terpineol	--	--	--	--	--	67
Pesticides/Herbicides						
aldrin*	7.1t	--	--	--	NA	NA
heptachlor*	24.2	--	--	--	NA	NA
etridazone	15t	--	--	--	NA	NA
azinphos ethyl	278	--	--	--	NA	NA
dioxathion	565	--	28t	--	NA	NA
trifluralin	--	--	3.8t	--	NA	NA
coumophos	--	--	45t	--	NA	NA
TEPP	--	--	18.2t	--	NA	NA
BHC, alpha*	--	10.4	--	--	NA	NA
phosmet	--	28t	--	42t	NA	NA
leptophos	--	--	--	11t	NA	NA
Metals						
calcium	11,000	14,000	20,000	15,000	90,200	1,350
magnesium	2,400	4,000	5,700	2,700	1,950	9,670
sodium	710,000	710,000	740,000	670,000	2,490	151,000
aluminum	1,900	4,200	5,100	2,500	2,040	1,350
manganese	100	250	390	110	179	1,100
lead*	1,300	4,200	3,600	1,900	1,560	850
vanadium	7	10	18	5	--	--
boron	540	430	560	390	--	535
barium	460	1,400	1,500	670	929	1,930
beryllium*	--	2	2	--	--	--
cadmium*	31	72	87	38	36	208
molybdenum	320	300	410	240	89	171
tin	--	79	110	--	67	--
cobalt	80	200	250	110	178	1,620
chromium*	470	780	660	570	124	128
copper*	990	2,300	2,500	1,300	1,030	72
iron	3,100	8,500	17,000	3,900	6,700	701
nickel*	67	99	190	57	39	174
titanium	48	130	120	67	60	--
zinc*	2,200	3,600	5,900	1,800	1,560	11,500
silver*	2.7	26	4.5	19	4	--
arsenic*	7.6	10	13	7.2	31	--
antimony*	20	20	30	16	67	--
mercury*	1	1.2	2.6	0.48	1.6	--

TABLE 5-6 (cont.)

Pollutant Category and Pollutant	Wastewater (µg/ℓ)				Solids	
	Raw Wastewater		Treated Wastewater		Thickened Sludge (µg/kg)	TCLP[1] Extract (µg/ℓ)
	Day 1	Day 2	Day 1	Day 2		
Elements						
iodine	DET	DET	DET	DET	DET	NA
iridium	DET	DET	--	--	DET	NA
potassium	--	DET	--	DET	--	NA
phosphorus	DET	DET	DET	DET	DET	NA
platinum	--	DET	--	--	--	NA
sulfur	DET	DET	DET	DET	DET	NA
silicon	DET	DET	DET	DET	DET	NA
strontium	--	--	--	--	DET	NA
thallium*	--	--	DET	--	NA	NA
tungsten	DET	DET	--	--	DET	NA
Cyanide						
cyanide, total*	300	230	270	200	38	NA
Other Pollutants						
residue, filterable	3,000	3,400	2,500	2,600	NA	NA
residue, non-filterable	930	1,000	1,000	970	NA	NA
fluoride	39	36	33	41	NA	NA
ammonia, as N	1.2[2]	1.1[1]	2.8	2.4	140	NA
nitrogen, Kjeldahl, total	12	35	15	64	6,700	NA
nitrate-nitrite, as N	1.4	1.5	0.42	1.3	3.4	NA
total phosphorus, as P	34	36	33	31	NA	NA
BOD-5 Day (carbonaceous)	1,900	1,800	360	440	NA	NA
chemical oxygen demand	5,800	4,900	2,900	2,800	NA	NA
oil and grease, total recoverable	1,200c	840c	310c	180c	NA	NA
total organic carbon	1,000	1,100	810	620	NA	NA
sulfide, total (iodometric)	2.0c	4.3c	4.3c	4.1c	NA	NA
Solid Waste Characteristics						
flash point	NA	NA	NA	NA	60°c	NA
pH, soil	NA	NA	NA	NA	9.8	NA
residue, total	NA	NA	NA	NA	29%	NA
residue, total volatile	NA	NA	NA	NA	68%	NA
sulfide, total (Monier-Williams)	NA	NA	NA	NA	78mg/ℓ	NA
Field Measurements						
pH	11.3-11.6	11.0	9.9-10.3	8.5-9.5		
temperature	30-33°C	32°C	28-32°C	32-34°C		
conductivity(µmho)	4400-4600	4400-4600	4400-4600	4400-4600		
settleable solids	1.0mℓ	<0.1 mℓ	0.5mℓ	1.1 mℓ		
flow (estimated)	0.1MGD	0.1MGD	0.1MGD	0.1MGD		

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* Priority Pollutant

-- Indicates pollutant concentration below detection limit.

NA Indicates not analyzed

c Average of grab sample results

t Denotes tentative identification below the detection limit.

[1] Toxicity Characteristic Leaching Procedure

[2] Sample pH was not within range specified by analytical method for preservation when received by the laboratory.

DET Indicates pollutant concentration qualitatively detected.

TABLE 5-7
SUMMARY OF REPORTED ANALYTICAL RESULTS
LAUNDRY B

Pollutant Category and Pollutant	Wastewater (µg/ℓ)					Solids	
	Raw Wastewater		Treated Wastewater				
	Day 1	Day 2	Day 1^1	Day 1^1	Day 2	DAF Sludge (µg/kg)	TCLP^2 Extract (µg/ℓ)
Volatile Organic Compounds							
2-hexanone	--	--	--	--	--	359	--
tetrachloroethene*	58	--	--	--	--	--	--
toluene*	415	--	--	152	--	376	33
trans-1,2-dichloroethene*	--	--	--	--	--	838	--
methylene chloride*	38	41	--	--	--	--	--
ethyl benzene*	103	913	--	--	69	938	--
acetone	493	1,840	--	--	140	--	--
Semi-volatile Organic Compounds							
alpha-terpineol	--	199	--	--	240	--	--
butyl-benzyl phthalate*	--	--	--	32	--	9,979	--
di-n-butyl phthalate*	--	--	--	--	--	--	55
indeno (1,2,3-CD) pyrene*	--	--	--	26	--	--	--
isophorone*	40	8,217	--	--	741	--	--
n-decane	--	34,154	--	--	16,003	--	17
biphenyl	--	33	--	--	--	--	--
n-docosane	--	--	--	--	--	--	24
n-dodecane	--	8,218	--	--	--	--	--
n-eicosane	--	2,515	--	--	96	--	--
n-hexacosane	--	--	--	36	--	--	--
n-hexadecane	94	846	--	121	663	20,793	20
n-octadecane	--	--	--	138	--	--	--
n-tetradecane	--	655	49	72	362	--	--
N-nitrosodi-n-propylamine*	--	850	--	--	--	--	--
naphthalene*	--	--	--	--	162	--	--
nitrobenzene*	38	--	--	--	22	--	--
p-cymene	--	--	--	--	98	--	--
styrene	--	102	--	--	--	--	--
2-chloronaphthalene*	--	4,403	--	--	4,565	--	--
2,6 dinitrotoluene*	--	--	--	--	--	--	47
3,3-dichlorobenzidine*	--	--	166	--	--	--	--
1,2:3,4 diepoxybutane	--	--	--	--	19	--	--
2-methylnaphthalene	186	112	--	121	--	--	--
Pesticides/Herbicides							
aldrin*	0.8	--	--	--	--	NA	NA
trifluralin	--	--	1.5t	1.8t	--	NA	NA
BHC, delta*	--	--	--	--	0.2	NA	NA
endosulfan sulfate*	--	--	--	--	1.5	NA	NA
etridazone	--	--	4.1t	--	5.4t	NA	NA
coumophos	--	--	--	--	7t	NA	NA
BHC, beta*	--	--	2.2	--	--	NA	NA
Dioxins/Furans							
2,3,7,8-TCDF	NA	NA	NA	NA	NA	28.27 (ng/kg)	NA
2,3,7,8-TCDD	NA	NA	NA	NA	NA	18.62 (ng/kg)	NA

TABLE 5-7 (continued)

Pollutant Category and Pollutant	Wastewater (µg/ℓ) Raw Wastewater Day 1	Wastewater (µg/ℓ) Raw Wastewater Day 2	Wastewater (µg/ℓ) Treated Wastewater Day 1^1	Wastewater (µg/ℓ) Treated Wastewater Day 1^1	Wastewater (µg/ℓ) Treated Wastewater Day 2	Solids DAF Sludge (µg/kg)	Solids TCLP^2 Extract (µg/ℓ)
Metals							
calcium	168,000	293,000	399,000	42,800	264,000	104,000	4,930,000
magnesium	35,000	5,080	9,700	11,100	4,660	8,000	27,800
sodium	249,000	279,000	285,000	349,000	313,000	1,580	144,000
aluminum	10,400	1,496	4,190	5,440	1,520	3,750	2,110
manganese	1,090	105	86	372	96	311	1,760
lead*	2,850	651	97	1,530	506	936	--
vanadium	44	9.1	42	15	6.2	--	--
boron	568	594	79	523	701	--	179
barium	1,560	281	823	1,390	311	701	116
beryllium*	2.3	--	--	1.4	--	--	--
cadmium*	66	26	173	42	28	31	--
molybdenum	202	73	118	189	94	160	155
tin	234	31	147	179	58	159	--
cobalt	345	71	172	324	95	148	1,340
chromium*	835	464	652	251	148	218	119
copper*	2,610	548	1,420	1,570	454	1,080	--
iron	634,000	6,140	17,600	20,200	4,760	19,599	5,200
nickel*	320	57	121	127	54	102	398
titanium	213	40	103	118	43	88	--
zinc*	6,250	1,450	3,130	3,130	1,220	2,070	4,880
silver*	37	8.5	21	19	7.7	49	--
arsenic*	12	<5	9.1	7.5	7.2	3.6	--
antimony*	60	28	57	40	24	14	50
mercury*	1.3	0.25	0.92	0.71	0.27	1.3	--
Elements							
iodine	DET	DET	DET	DET	DET	DET	NA
iridium	DET	--	--	--	--	DET	NA
potassium	--	DET	DET	--	DET	--	NA
phosphorus	DET	DET	DET	DET	--	DET	NA
sulfur	DET	DET	DET	DET	DET	DET	NA
selenium	--	DET	DET	--	--	NA	NA
silicon	DET	DET	DET	DET	DET	--	NA
strontium	--	DET	DET	--	DET	DET	NA
thallium*	DET	DET	DET	--	DET	NA	NA
tungsten	--	--	--	--	--	DET	NA

TABLE 5-7 (continued)

Pollutant Category and Pollutant	Wastewater (mg/ℓ) Raw Wastewater Day 1	Wastewater (mg/ℓ) Raw Wastewater Day 2	Wastewater (mg/ℓ) Treated Wastewater Day 1[1]	Wastewater (mg/ℓ) Treated Wastewater Day 1[1]	Wastewater (mg/ℓ) Treated Wastewater Day 2	Solids DAF Sludge (μg/kg)	Solids TCLP[2] Extract (μg/ℓ)
Cyanide							
cyanide, total*	170	220	270	210	120	11	NA
Other Pollutants							
residue, filterable	1,000	2,200	2,200	1,800	2,000	NA	NA
residue, non-filterable	1,100	200	270	740	340	NA	NA
fluoride	16	14	16	23	15	NA	NA
ammonia, as N	--	--	--	--	--	420	NA
nitrogen, Kjeldahl, total	16	13	13	14	4.2	4,500	NA
nitrate-nitrite, as N	1.2	0.35	0.44	0.21	0.68	--	NA
total phosphorous, as P	15	6.7	9.2	26	6.9	NA	NA
BOD-5 Day (carbonaceous)	680	390	390	1,500	730	NA	NA
chemical oxygen demand	3,300	1,600	1,700	4,800	2,000	NA	NA
oil and grease, total recoverable	410c	140c	140c	650c	220c	NA	NA
total organic carbon	470	390	820	820	340	NA	NA
sulfide, total (iodometric)	1.3c	2.3c	3.1c	3.8c	3.4c	NA	NA
Solid Waste Characteristics							
flash point	NA	NA	NA	NA	NA	57°c	NA
pH, soil	NA	NA	NA	NA	NA	7.3	NA
residue, total	NA	NA	NA	NA	NA	29%	NA
residue, total volatile	NA	NA	NA	NA	NA	57%	NA
sulfide, total (Monier-Williams)	NA	NA	NA	NA	NA	1,100mg/ℓ	NA
Field Measurements							
pH	9.2-9.7	6.9-7.8		9.2-9.6	7.7-8.2		
temperature	36-37°C	34-37°C		37-40°C	36-40°C		
conductivity (μmho)	1450-1770	2360-2900		1217-1960	1965-2820		
settleable solids	1 mℓ	4 mℓ		0.5 mℓ	1 mℓ		
Flow (estimated)	0.060MGD	0.060MGD		0.060MGD	0.060MGD		

---

* Priority Pollutant

-- Indicates pollutant concentration below detection limit.

NA Indicates not analyzed

c Average of grab sample results

t Denotes tentative identification below the detection limit.

[1] Two sets of samples of treated effluent wastewater were collected and analyzed independently on day 1 for quality control/quality assurance.

[2] Toxicity Characteristic Leaching Procedure.

DET Indicates pollutant concentration qualitatively detected.

TABLE 5-8
SUMMARY OF REPORTED ANALYTICAL RESULTS
LAUNDRY C

Pollutant Category and Pollutant	Process Water (µg/ℓ)	Wastewater - (µg/ℓ)				Solids	
		Raw Wastewater		Treated Effluent		Sludge (µg/kg)	TCLP[1] Extract (µg/ℓ)
		Day 1	Day 2	Day 1	Day 2		
Volatile Organic Compounds							
acetone	828	1,701	17,457	1,701	1,116	621,909	6,245
acrolein*	--	--	--	--	601	--	--
2-butanone	--	--	16,762	--	--	--	--
chlorobenzene*	--	--	--	49	--	--	--
di-n-butyl phthalate*	--	--	--	--	--	--	20
ethyl benzene*	--	--	46	--	--	10,909	165
isobutyl alcohol	43	138	--	--	--	4,000	85
methylene chloride*	--	21	--	--	--	--	--
tetrachloroethene*	--	314	843	148	645	50,455	146
toluene*	20	233	6,638	--	914	650,727	7,327
trans-1,2-dichloroethene*	--	--	10	93	22	5,818	5,824
1,1,1-trichloroethane*	--	--	73	--	192	--	--
vinyl acetate	--	14	--	--	--	2,091	--
Semi-volatile Organic Compounds							
biphenyl	--	--	11	--	--	--	--
bis(2-ethylhexyl) phthalate*	--	--	112	1,900	129	850,909	17
diphenylamine	--	--	36	--	23	--	--
isophorone*	--	--	32	--	25	--	--
naphthalene*	--	--	--	--	25	--	--
n-decane	--	--	--	2,687	--	--	--
N-nitrosodiphenylamine*	--	--	39	--	--	--	--
n-triacontane	--	--	--	--	224	--	--
p-cymene	--	--	84	--	14	116,818	--
phenanthrene*	--	--	19	--	--	--	--
Pesticides/Herbicides							
endosulfan sulfate	--	--	74	--	--	328	NA
Metals							
calcium	8,290T	23,400	21,500	14,900	15,600	12,800	20,300
magnesium	1,420T	7,250	5,540	3,560	4,080R	4,040	6,490
sodium	9,280T	1,310,000	727,000	476,000	527,000	29,400	422,000
aluminum	--	6,730	10,600	4,210	3,930R	5,020	7,900
manganese	--	343	373	207	151R	396	874
lead*	--	970	3,540	956	2,890	989	1,760
boron	--	242	551	163	160R	--	--
barium	--	762	738	552	641	639	967
cadmium*	--	57	284	38	53Rd	30	93
molybdenum	--	--	102	--	--	--	159
tin	--	47	234	43	92R	232	335
cobalt	--	--	--	--	--	--	68
chromium*	--	185	223	136	104	227	229
copper*	--	1,290	1,630	902	564R	1,340	2,760
iron	133	19,700	28,900	13,400	10,200	34,500	35,900
nickel*	--	152	176	88	57Rd	296	46
titanium	--	227	270	156	113R	326	497
zinc*	--	3,920	4,610	2,440	2,670	2,420	4,090
silver*	--	--	--	--	--	6.0	17
arsenic*	--	--	15S	--	--	17S	--
antimony*	--	30	123	34	76	--	45
mercury*	--	2.2	--	2.5	--	--	0.3
Elements							
iodine	--	DET	DET	DET	DET	--	NA
potassium	--	DET	--	--	--	--	NA
phosphorus	--	DET	DET	DET	DET	DET	NA
sulfur	DET	DET	DET	DET	DET	DET	NA
zirconium	--	--	DET	--	--	--	NA
silicon	DET	DET	DET	DET	DET	DET	NA

TABLE 5-8 (cont.)

Pollutant Category and Pollutant	Process Water (µg/ℓ)	Wastewater - (µg/ℓ)				Solids	
		Raw Wastewater		Treated Effluent			
		Day 1	Day 2	Day 1	Day 2	Sludge (µg/kg)	TCLP[1] Extract (µg/ℓ)
strontium	--	DET	DET	DET	DET	DET	NA
lithium	--	DET	DET	DET	DET	--	NA
tungsten	--	--	--	--	--	--	NA
osmium	--	--	--	DET	--	--	NA
Cyanide							
cyanide, total*	--	17	0.160	0.810	2.1	6.6	NA
Other Pollutants							
residue, filterable	--	4,800	2,600	2,300	2,000	NA	NA
residue, non-filterable	--	760	930b	400	140	NA	NA
fluoride	--	13	20	10	12	NA	NA
ammonia, as N	--	--	--	--	--	7.0	NA
nitrogen, Kjeldahl, total	--	18	14	13	13	48**	NA
nitrate-nitrite, as N	--	0.41	0.48	0.56	0.32	0.62	NA
total phosphorous, as P	--	45	38	25	46	NA	NA
BOD-5 Day (carbonaceous)	--	800	900	720	290	NA	NA
chemical oxygen demand	--	4,800	6,100	3,400	2,300	NA	NA
oil and grease, total recoverable	--	920c	140c	470c	460c	NA	NA
total organic carbon	--	710	520	370	420	NA	NA
sulfide, total (iodometric)	--	5.6c	5.9c	3.2c	2.2c	NA	NA
Solid Waste Characteristics							
flash point	NA	NA	NA	NA	NA	60°C	NA
pH, soil	NA	NA	NA	NA	NA	10.2	NA
residue, total	NA	NA	NA	NA	NA	11,000	NA
residue, total volatile	NA	NA	NA	NA	NA	5,300	NA
sulfide, total (Monier-Williams)	NA	NA	NA	NA	NA	10	NA
corrosivity	NA	NA	NA	NA	NA	--	NA
Field Measurements							
temperature	NA	26-27°C	24-26°C	15-27°C	22-24°C	NA	NA
pH	NA	10.3-12.2	10.5-11.9	10.3-11.6	11.5	NA	NA
settleable Solids	NA	5.5mg/ℓ	0.7mg/ℓ	0.4mg/ℓ	0.1mg/ℓ	NA	NA
flow (estimated)				0.040MGD	0.040MGD		

-- Indicates pollutant concentration below detection limit.
NA Indicates not analyzed.
DET Indicates pollutant concentration qualitatively detected.
* Priority pollutant.
** Mean of 5 replicate analyses.
b Analysis performed after expiration of analytical "hold-time".
c Average of grab sample results.
d Indicates duplicate analysis not within control limit.
R Indicates spike recovery not within control limit.
S Indicates value determined by Method of Standard Addition.
1 Toxicity Characteristic Leaching Procedure

TABLE 5-9
SUMMARY OF REPORTED ANALYTICAL RESULTS
WATER AND WASTEWATER SAMPLES
LAUNDRY D

Pollutant Category and Pollutant	Process Water (µg/ℓ)	Uniform Washers Wastewater (µg/ℓ)				Shop Towel Washers Wastewater (µg/ℓ)					
		Raw Wastewater		Treated Effluent		Raw Wastewater		Strainer Effluent		Treated Effluent	
		Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
Volatile Organic Compounds											
acetone	--	141	61	635	1,079	--	1,466	--	1,785	--	16,847
acrolein*	--	--	--	1,406	--	--	--	--	--	--	--
benzene*	--	--	--	--	--	--	--	--	--	--	--
bromodichloromethane*	--	--	--	--	--	--	--	--	--	--	--
carbon tetrachloride*	--	--	--	--	--	--	--	--	--	--	--
chlorobenzene*	--	--	--	--	--	--	142	--	202	--	--
chloroform*	--	--	--	--	--	--	--	--	--	--	--
dibromochloromethane*	--	--	--	--	--	--	--	--	--	--	--
ethylbenzene*	--	--	--	162	38	36,031	638	1,301	1,174	49	--
methacrylonitrile	--	--	--	--	--	--	--	--	--	--	--
methylene chloride*	--	1,165	902	937	113	39,933	32	5,152	28	887	555
p-dioxane	--	--	--	--	--	--	--	--	--	--	--
tetrachloroethene*	--	92	--	351	66	55,516	3,403	2,369	2,615	695	576
toluene*	--	136	--	3,933	383	--	11,594	70,742	7,116	1,623	2,861
trans-1,2-dichloroethene*	--	--	--	--	--	713	--	--	--	--	--
trichloroethene*	--	--	--	--	--	--	64	--	57	--	--
1,1-dichloroethane*	--	--	33	--	--	--	--	--	--	--	--
1,1-dichloroethene*	--	--	--	--	--	1,087	--	123	--	--	--
1,1,1-trichloroethane*	--	--	--	64	47	38,331	691	2,323	934	375	540
1,1,2,2-tetrachloroethane*	--	--	--	--	--	--	--	--	--	--	--
2-butanone	--	--	--	--	--	--	--	89,429	590	9,294	8,124
2-chloroethylvinyl ether*	--	--	--	--	--	--	108	--	23	--	--
4-methyl-2-pentanone	--	--	--	--	--	--	--	385	--	--	--
Semi-volatile Organic Compounds											
alpha terpineol	--	580	--	1,789	--	16,798	--	21,274	--	727	--
anthracene*	--	--	--	--	--	--	--	--	--	--	--
benzidine*	--	--	--	--	--	22,436	--	--	--	--	--
bis(2-ethyhexyl)phthalate*	--	1,040	--	1,040	--	9,441	--	9,155	--	--	--
di-n-butyl phthalate*	--	--	--	--	--	--	--	--	--	--	--
di-n-octyl phthalate*	--	--	29	--	--	--	--	--	--	--	--
dimethyl phthalate*	--	--	--	--	--	--	--	--	--	13	--
diphenylamine	--	--	--	--	--	--	--	--	--	22	--
isophorone*	--	--	--	--	--	--	--	1,131	--	--	203
n-decane	--	488	--	--	168	30,652	--	--	--	--	--
n-dodecane	--	--	--	--	--	--	--	--	--	--	--
n-hexacosane	--	--	--	--	--	--	--	--	--	--	--

TABLE 5-9 (continued)

Pollutant Category and Pollutant	Process Water (μg/ℓ)	Uniform Washers Wastewater (μg/ℓ)				Shop Towel Washers Wastewater (μg/ℓ)					
		Raw Wastewater		Treated Effluent		Raw Wastewater		Strainer Effluent		Treated Effluent	
		Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
n-hexadecane	--	--	--	--	--	--	17,456	--	21,280	--	--
N-nitrosodiphenylamine*	--	--	--	--	--	--	--	--	--	22	--
n-octadecane	--	316	--	209	--	--	22,089	--	--	--	--
n-tetradecane	--	--	29	--	--	--	--	--	--	--	--
naphthalene*	--	688	--	753	--	5,025	--	4,673	--	400	--
o-cresol	--	--	--	--	--	--	--	--	--	--	254
p-cymene	--	--	--	253	--	8,111	--	7,601	--	--	--
phenanthrene*	--	--	--	--	--	--	--	--	1,417	--	--
styrene	--	--	--	--	--	--	--	--	--	--	--
1,2-dichlorobenzene*	--	--	--	--	--	--	--	--	--	12	--
2-chloronaphthalene*	--	288	--	--	--	--	--	--	--	25	--
2,4-dichlorophenol*	--	--	--	--	16	--	--	--	--	--	--
4-chloro-3-methyl phenol*	--	--	--	--	--	--	--	--	--	109	478
Pesticides/Herbicides											
endosulfan Sulfate*	--	1,067	NA	1,397	--	2,152	--	2,898	NA	--	--
heptachlor*	--	--	NA	--	--	--	--	--	NA	--	--
tetrachlorovinphos	--	969	NA	--	--	--	--	1,344	NA	--	--
dioxathion	--	--	NA	2,524	b	--	b	--	NA	--	--
leptophos	--	--	NA	436	b	--	b	--	NA	--	--
chlorpyrophos methyl	--	--	NA	3,563	NA	--	NA	6,874	NA	--	--
EPN	--	--	NA	--	--	5,529	--	--	NA	--	--
coumaphos	--	--	NA	--	--	--	--	--	NA	--	--
phosmet	--	--	NA	--	--	--	--	--	NA	--	--
azinphos methyl	--	--	NA	--	b	--	NA	--	NA	--	--
chlorfenvinphos	--	--	NA	--	--	--	b	--	NA	--	--
crotoxyphos	--	--	NA	--	--	--	b	--	NA	--	--
naled	--	--	NA	--	--	--	--	--	NA	--	b
Metals											
aluminum	374	9,000	9,210	6,550	6,680	19,300	11,300	17,500	21,500	773	664
barium	--	806	943	745	818	4,480	2,620	4,100R	5,230	58	--
beryllium*	--	--	5	--	--	--	--	--	6	--	--
boron	--	555	799	635	557	1,740	819	1,680R	1,100	1,880	1,210
cadmium*	--	254	105	91	97	856	365	814	786	11	--
calcium	19,400	47,400	46,500	36,800	37,300	62,000	43,800	65,000R	73,500	8,840	7,180
chromium*	--	436	268	173	200	1,170	815	1,240	1,410	243	173
cobalt	--	73	50	53	--	795	319	941R	630	--	--
copper*	--	2,060	1,470	1,150	1,340	9,070	7,690	10,300	29,000	112	83
iron	72	63,600	24,100	18,500	17,300	114,000	65,600	90,400T	164,000	1,060	792
lead*	--	2,620	1,460	1,420	1,750	20,500	15,400	19,600	24,200	407	324
magnesium	3,010	13,200	13,400	9,600	10,100	18,500	10,300	18,300	20,500	313	--
manganese	36	880	431	393	333	1,950	1,210	2,000	2,300	--	--

TABLE 5-9 (continued)

Pollutant Category and Pollutant	Process Water (µg/ℓ)	Uniform Washers Wastewater (µg/ℓ) Raw Wastewater Day 1	Day 2	Treated Effluent Day 1	Day 2	Shop Towel Washers Wastewater (µg/ℓ) Raw Wastewater Day 1	Day 2	Strainer Effluent Day 1	Day 2	Treated Effluent Day 1	Day 2
molybdenum	--	190	100	149	--	1,270	369	1,140R	699	253	439
nickel*	--	868	227	173	152	1,610	693	1,660	1,560	82	85
sodium	13,000	175,000	106,000	202,000	186,000	723,000	827,000	647,000	805,000	787,000	651,000
tin	--	274	91	72	--	536	808	521	1,410	--	--
titanium	--	242	323	232	188	574	244	472	473	--	--
vanadium	--	--	58	--	91	113	56	106R	178	--	--
yttrium	--	--	--	--	--	--	--	--	--	--	--
zinc*	294	5,020	5,450	3,870	4,200	13,100	9,480	13,100	17,900	137	76
antimony*	--	108	28s+	91	91	213	369	205	633	281	179
arsenic*	--	11s	--	--	--	17	--	--	25	--	--
mercury*	--	2.6	3.6	3.3	2.5	3.5	--	2.5	3.2	--	--
selenium*	--	--	--	--	--	--	--	--	--	--	--
silver*	--	48	35	45	24	877	46	732	24	--	--
thallium*	--	--	--	--	--	--	--	--	--	--	--
Elements											
iodine	--	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET
iridium	--	--	--	--	--	DET	DET	DET	DET	--	--
lanthanum	--	--	--	--	--	--	--	--	--	--	--
lithium	--	--	--	--	--	DET	DET	DET	DET	DET	DET
phosphorus	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET
potassium	--	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET
silicon	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET
strontium	--	DET	DET	DET	DET	DET	DET	DET	DET	--	--
sulfur	--	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET
tungsten	--	--	--	--	--	DET	--	DET	DET	DET	DET
zirconium	--	--	--	--	--	--	--	--	--	--	--
Cyanide											
cyanide, total*	NA	--	--	37	41	110	130	92	130	200	280

TABLE 5-9 (continued)

Pollutant Category and Pollutant	Process Water (μg/ℓ)	Uniform Washers Wastewater (mg/ℓ)				Shop Towel Washers Wastewater (mg/ℓ)					
		Raw Wastewater		Treated Effluent		Raw Wastewater		Strainer Effluent		Treated Effluent	
		Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
Other Pollutants											
residue, filterable	NA	1,300	1,900	1,400	1,500	2,000	11,000	1,100	8,800	2,600	2,500
residue, non-filterable	NA	770	490	620	500	4,700	4,200	7,000	24,000	23	16
fluoride	NA	13	15	14	22	2.8	NR	1.6	NR	15	3.1
ammonia, as N	NA	1.7	1.4	1.2	--	1.9	--	--	--	--	--
nitrogen, kjeldahl, total	NA	71	17	1.5	10	5.0	4.2	<20*	2.6	13	10
nitrate-nitrite, as N	NA	0.82	0.70	0.41	0.62	0.47	1.4	0.83	0.34	0.72	0.43
total phosphorus, as P	NA	7.5	73	32	36	1.9	7.0	8.5	7.8	24	20
BOD-5 day (carbonaceous)	NA	540	610	670	420	2,200	2,900	>7,400¹	3,900	770	1,000
chemical oxygen demand	NA	3,000	3,600	3,000	3,300	10,000	11,000	17,000	7,200	1,900	2,000
oil and grease total recoverable	NA	240**	260**	4,800**	570**	4,500**	7,700**	3,100**	2,800**	8.6*	76**
total organic carbon	NA	280	410	290	290	750	1,200	780	690	500	480
sulfide, total (iodometric)	NA	--	3.1**	--	5.8**	NR	5.8**	1.9**	4.3**	1.5**	3.3**
Solid Waste Characteristics											
flash point	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
pH, soil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
residue, total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
residue, total volatile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
sulfide, total (Monier-williams)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
corrosivity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Field Measurements											
temperature	NA	36-40°C	20-45°C	25-36°C	27-40°C	25-36°C	21-45°C	24-39°C	22-45°C	34°C	32-36°C
pH	NA	9.1-11.1	9.5-11.5	9.0-11.2	10.2-11.5	10.1-10.6	9.8-11.9	8.0-10.5	9.7-12.0	10.1-11.0	11.1-12.2
settleable Solids	NA	2.7 mℓ/ℓ	0.6 mℓ/ℓ	0.4 mℓ/ℓ	0.5 mℓ/ℓ	8.0 mℓ/ℓ	1.0 mℓ/ℓ	3 mℓ/ℓ	--	--	--
flow (estimated)				29,200 GPD						11,700 GPD	

* Priority pollutant
-- Indicates pollutant concentration below detection limit
** Composite of results for 3 grab samples
NA Indicates not analyzed
NR No data reported due to matrix interference
*** Low bias indicated based on recovery of sulfide standard analyzed concurrently with sample
1 Seed inhibition indicated
2 Oxygen depletion exceeded limiting value of 1 mg/ℓ during incubation. BOD_5 result calculated from limiting value
a Estimated long-term average
S Indicates value determined by Method of Standard Addition
+ Indicates the correlation coefficient for Method of Standard Addition is less than 0.995
R Indicates spike recovery is not within control limits
T Indicates duplicate analysis is not within control limits
b Indicates compound was found above the detection limit, but the analysis could not be confirmed. The results may be found in the Appendix.

TABLE 5-10
SUMMARY OF REPORTED ANALYTICAL RESULTS
SOLIDS AND OILS SAMPLES
LAUNDRY D

Pollutant Category and Pollutant	Uniform Washers						Shop Towel Washers				
	1st Settling Basin		Shaker Screen		2nd Settling Basin		Disc Strainer		Oil Skimmer	Ultrafilter Concentrate	
	Solids (μg/kg)	TCLP (μg/ℓ)	Solids (μg/kg)	TCLP (μg/ℓ)	Solids (μg/kg)	TCLP (μg/ℓ)	Solids (μg/kg)	TCLP (μg/ℓ)	Oil (μg/kg)	(μg/kg)	TCLP (μg/ℓ)
Volatile Organic Compounds											
acetone	2,900	705	--	179	1,772	1,298	--	1,314	17,852	--	NA
acrolein*	--	--	--	--	--	--	--	--	--	--	NA
benzene*	--	--	--	--	--	--	--	--	--	69	NA
bromodichloromethane*	--	--	--	--	--	--	--	--	--	22	NA
carbon tetrachloride*	--	--	122	--	--	--	--	--	--	118	NA
chlorobenzene*	--	--	--	--	--	--	--	--	--	--	NA
chloroform*	--	--	--	--	--	--	--	--	--	142	NA
dibromochloromethane*	--	--	--	--	--	--	--	--	--	15	NA
ethylbenzene*	--	--	104	--	97	22	231	--	6,233	64,950	NA
methacrylonitrile	--	--	--	--	--	--	--	--	--	109	NA
methylene chloride*	100	59	396	26	--	78	--	44	838	7,119	NA
p-dioxane	--	--	--	--	--	--	--	--	--	75,785	NA
tetrachloroethene*	1,535	20	196	72	63	30	29,995	1,660	117,868	1,620,900	NA
toluene*	869	38	78	--	--	169	5,579	425	92,109	518,720	NA
trans-1,2-dichloroethene*	--	--	--	--	--	--	--	--	--	--	NA
trichloroethene*	--	--	--	--	--	22	192	101	1,138	116	NA
1,1-dichloroethane*	49	--	--	--	--	25	62	71	--	153	NA
1,1-dichloroethene*	--	--	--	--	--	--	--	--	2,531	15,794	NA
1,1,1-trichloroethane*	--	--	--	--	--	--	136	--	36,041	153,681	NA
1,1,2,2-tetrachloroethane*	--	--	--	--	--	--	--	--	--	343	NA
2-butanone	--	56	--	--	--	78	--	--	--	--	NA
2-chloroethylvinyl ether*	--	--	--	--	--	--	--	--	--	--	NA
4-methyl-2-pentanone	--	--	--	--	--	--	--	--	--	--	NA
Semi-volatile Organic Compounds											
alpha terpineol	--	--	--	--	--	--	--	31	--	146,470	NA
anthracene*	--	--	3,039	--	--	--	--	--	--	--	NA
benzidine*	--	--	--	--	--	--	--	--	--	--	NA
bis(2-ethyhexyl)phthalate*	--	--	--	--	20,881	--	--	--	222,110	241,880	NA
di-n-butyl phthalate*	--	--	13,987	--	--	13	--	--	--	140,330	NA
di-n-octyl phthalate*	--	--	--	--	--	--	--	--	--	--	NA
dimethyl phthalate*	--	--	3,191	--	--	--	--	--	--	--	NA
diphenylamine	--	--	--	--	--	--	--	--	--	--	NA
isophorone*	--	--	--	--	--	--	--	--	--	--	NA
n-decane	--	--	--	--	--	--	10,374	--	--	1,618,540	NA
n-dodecane	--	--	--	--	--	--	--	--	--	496,320	NA
n-hexacosane	--	--	40,335	--	--	--	--	--	--	--	NA

TABLE 5-10 (continued)

Pollutant Category and Pollutant	Uniform Washers						Shop Towel Washers				
	1st Settling Basin		Shaker Screen		2nd Settling Basin		Disc Strainer		Oil Skimmer	Ultrafilter Concentrate	
	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Oil (µg/kg)	(µg/kg)	TCLP (µg/ℓ)
n-hexadecane	--	--	28,330	--	--	--	8,867	--	--	--	NA
N-nitrosodiphenylamine*	--	--	--	--	--	--	--	--	--	--	NA
n-octadecane	--	--	35,813	--	--	--	--	--	--	217,380	NA
n-tetradecane	--	--	--	--	--	--	--	--	--	--	NA
naphthalene*	--	--	--	19	--	--	--	--	114,800	147,790	NA
o-cresol	--	--	--	--	--	--	--	--	--	--	NA
p-cymene	--	--	--	--	--	--	--	--	110,120	--	NA
phenanthrene*	--	--	4,378	--	--	--	--	--	--	--	NA
styrene	--	--	3,822	--	--	--	--	--	--	--	NA
1,2-dichlorobenzene*	--	--	--	--	--	--	--	--	--	--	NA
2-chloronaphthalene*	--	--	--	--	--	--	--	--	--	--	NA
2,4-dichlorophenol*	--	--	--	--	--	--	--	--	--	--	NA
4-chloro-3-methyl phenol*	--	--	--	--	--	--	--	--	--	--	NA
Pesticides/Herbicides											
endosulfan sulfate	--	NA	--	NA	2,378	NA	--	NA	--	--	NA
heptachlor	--	NA	--	NA	--	NA	--	NA	1,239	--	NA
tetrachlorovinphos	--	NA	--	NA	--	NA	--	NA	--	825	NA
dioxathion	--	NA	--	NA	--	NA	--	NA	--	--	NA
leptophos	--	NA	--	NA	--	NA	--	NA	--	1,065	NA
chlorpyrophos methyl	--	NA	--	NA	--	NA	--	NA	--	--	NA
EPN	--	NA	--	NA	--	NA	22,241	NA	--	--	NA
coumophos	--	NA	--	NA	--	NA	17,168	NA	22,673	--	NA
phosmet	--	NA	--	NA	--	NA	--	NA	--	1,921	NA
azinphos methyl	--	NA	--	NA	--	NA	--	NA	--	--	NA
chlorfenvinphos	--	NA	--	NA	--	NA	--	NA	--	--	NA
crotoxyphos	--	NA	--	NA	--	NA	--	NA	--	--	NA
naled	--	NA	--	NA	--	NA	--	NA	--	--	NA
Metals											
aluminum	452,000	67[illegible]	14,200	1,180	7,590	3,040	16,900	292	1,860	1,350	1,250
barium	1,090	599	177	651	572R	1,490	331	1,110	277	340	4,640
beryllium*	9	--	6	--	1	--	8	--	--	--	--
boron	225	--	21	342	45R	736	57	649	24	--	2,190
cadmium*	106	491	13	139	99T	559	79	584	105	68	725
calcium	140,000	180,000	13,300	83,300	22,300	395,000	8,380	132,000	7,190	5,020	97,100
chromium*	4,780	39	325	75	372T	29T	923	70	216	38	23
cobalt	309	183	25	78	59R	483	153	590	79	36	396
copper*	53,200	170	5,080	398	2,550	180T	8,790	88	3,550	520	1,060
iron	921,000	280,000	36,800	56,700	57,200T	99,100	83,900	359,000	15,600	4,400	1,650
lead*	4,770	137	640	457	1,100	1,200T	1,700	1,140	6,930	2,890	5,750
magnesium	59,900	4,640	5,550	4,350	8,450	18,000T	3,900	5,860	1,880	1,500	14,300
manganese	3,420	3,860	329	1,080	460	3,810	606	4,210	215	130	1,760

TABLE 5-10 (continued)

Pollutant Category and Pollutant	Uniform Washers						Shop Towel Washers				
	1st Settling Basin		Shaker Screen		2nd Settling Basin		Disc Strainer		Oil Skimmer	Ultrafilter Concentrate	
	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Oil (µg/kg)	(µg/kg)	TCLP (µg/ℓ)
molybdenum	561	--	40	--	98R	--	254	--	179	44	--
nickel*	4,150	1,240	225	313	541	2,900	1,120	2,080	279	43	466
sodium	5,380	1,390,000	646	1,320,000	996	1,380,000	2,140	1,440,000	3,580	3,570	1,740,000
tin	997	--	303	--	154	--	248	--	101	46	--
titanium	2,070	--	160	--	417	--	184	--	72	42	--
vanadium	239	--	22	--	243T	--	60	--	14	--	--
yttrium	45	--	--	--	7	--	7	--	3	--	--
zinc*	12,600	15,700	1,520	5,990	2,090	20,200	3,110	22,600	3,440	1,480	2,180
antimony*	44	--	16	--	23R	--	34	22S+	312	41	40
arsenic*	2S	--	5S+	--	--	--	--	--	--	--	--
mercury*	0.5	--	--	0.3	1.1	--	0.9	--	--	0.1	--
selenium*	1	--	--	--	2T	--	1	--	--	3T	--
silver*	417	--	17	--	145	--	85	--	40.3	8.0	--
thallium*	--	--	--	--	--	--	--	--	--	--	--
Elements											
iodine	--	NA	--	NA	DET	NA	--	NA	--	--	NA
iridium	DET	NA	DET	NA	DET	NA	DET	NA	DET	--	NA
lanthanum	--	NA	--	NA	DET	NA	--	NA	--	--	NA
lithium	--	NA	--	NA	--	NA	--	NA	--	--	NA
phosphorus	DET	NA	DET	NA	DET	NA	DET	NA	DET	DET	NA
potassium	--	NA	--	NA	--	NA	--	NA	--	--	NA
silicon	DET	NA	DET	NA	DET	NA	DET	NA	DET	DET	NA
strantium	DET	NA	DET	NA	DET	NA	DET	NA	--	DET	NA
sulfer	DET	NA	DET	NA	DET	NA	DET	NA	DET	DET	NA
tungston	--	NA	--	NA	DET	NA	DET	NA	--	--	NA
zirconium	--	NA	--	NA	DET	NA	--	NA	--	--	NA
Cyanide											
cyanide, total*	2,200	NA	--	NA	--	NA	3,100	NA	NA	600	NA

TABLE 5-10 (continued)

Pollutant Category and Pollutant	Uniform Washers: 1st Settling Basin Solids (mg/kg)	Uniform Washers: 1st Settling Basin TCLP (mg/ℓ)	Uniform Washers: Shaker Screen Solids (mg/kg)	Uniform Washers: Shaker Screen TCLP (mg/ℓ)	Uniform Washers: 2nd Settling Basin Solids (mg/kg)	Uniform Washers: 2nd Settling Basin TCLP (mg/ℓ)	Shop Towel Washers: Disc Strainer Solids (mg/kg)	Shop Towel Washers: Disc Strainer TCLP (mg/ℓ)	Shop Towel Washers: Oil Skimmer Oil (mg/kg)	Shop Towel Washers: Ultrafilter Concentrate (mg/kg)	Shop Towel Washers: Ultrafilter Concentrate TCLP (mg/ℓ)
Other Pollutants											
residue, filterable	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,300	NA
residue, non-filterable	NA	NA	NA	NA	NA	NA	NA	NA	NA	58,000	NA
fluoride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NR	NA
ammonia, as N	--	NA	120	NA	830	NA	--	NA	NA	33	NA
nitrogen, kjeldahl, total	1,100	NA	3,900	NA	4,200	NA	1,600	NA	NA	NR	NA
nitrate-nitrite, as N	1.1	NA	4.1	NA	5.5	NA	5.5	NA	NA	0.87	NA
total phosphorus, as P	NA	NA	NA	NA	NA	NA	NA	NA	NA	NR	NA
BOD-5 day (carbonaceous)	NA	NA	NA	NA	NA	NA	NA	NA	NA	>23,000^2	NA
chemical oxygen demand	NA	NA	NA	NA	NA	NA	NA	NA	NA	440,000	NA
oil and grease											
total recoverable	NA	NA	NA	NA	NA	NA	NA	NA	NA	29,000	NA
total organic carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NR	NA
sulfide, total (iodometric)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NR	NA
Solid Waste Characteristics											
flash point	32°C	NA	42°C	NA	30°C	NA	52°C	NA	NA	NA	NA
pH, soil	8.8	NA	8.1	NA	7.5	NA	9.9	NA	NA	NA	NA
residue, total	49%	NA	23%	NA	32%	NA	39%	NA	NA	NA	NA
residue, total volatile	3.9%	NA	20%	NA	31%	NA	26%	NA	NA	NA	NA
sulfide, total											
(Monier-Williams)	110***	NA	87	NA	330	NA	150***	NA	NA	NA	NA
corrosivity	--	NA	--	NA	--	NA	--	NA	NA	NA	NA
Field Measurements											
temperature	NA	NA	NA	NA	NA	NA	NA	NA	NA	31°C	NA
pH	NA	NA	NA	NA	NA	NA	NA	NA	NA	11.8	NA
settleable Solids	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

*	Priority
--	Indicates pollutant concentration below detection limit
**	Composite of results for 3 grab samples
NA	Indicates not analyzed
NR	No data reported due to matrix interference
***	Low bias indicated based on recovery of sulfide standard analyzed concurrently with sample
1	Seed inhibition indicated
2	Oxygen depletion exceeded limiting value of 1 mg/ℓ during incubation. BOD5 result calculated from limiting value
S	Indicates value determined by Method of Standard Addition
+	Indicates the correlation coefficient for Method of Standard Addition is less than 0.995
R	Indicates spike recovery is not within control limits
T	Indicates duplicate analysis is not within control limits
TCLP	Toxicity characteristic leaching procedure

TABLE 5-11
SUMMARY OF AVERAGE RAW WASTE CONCENTRATIONS FOR COMBINED UNIFORM WASHERS AND TOWEL WASHERS WASTEWATER STREAMS AT LAUNDRY D

Pollutant Category and Pollutant	Combined Average Raw Waste Load[1]	
	Day 1 (µg/ℓ)	Day 2 (µg/ℓ)
Volatile Organic Compounds		
acetone	101	463
chlorobenzene*	--	41
ethylbenzene*	10,307	183
methylene chloride*	12,255	653
tetrachloroethene*	15,947	973
toluene*	97	3,317
trans-1,2-dichloroethene*	204	--
trichloroethene*	--	18
1,1-dichloroethane*	--	24
1,1-dichloroethene*	311	--
1,1,1-trichloroethane*	10,965	198
2-chloroethylvinyl ether*	--	31
Semi-volatile Organic Compounds		
alpha-terpineol	5,219	--
benzidine*	6,418	--
bis(2-ethylhexyl)phthalate*	3,443	--
di-n-octyl phthalate*	--	21
n-decane	9,117	--
n-hexadecane	--	4,994
n-octadecane	226	6,319
n-tetradecane	--	21
naphthalene*	1,929	--
p-cymene	2,320	--
2-chloronaphthalene*	206	--
Pesticides/Herbicides		
endosulfan sulfate*	1,377	--
tetrachlorovinphos	692	--
EPN	1,582	--
Metals		
aluminum	6,164	9,808
barium	1,857	1,423
beryllium*	--	4
boron	894	805
cadmium*	426	179
calcium	51,577	45,728
chromium*	646	424
cobalt	280	127
copper*	4,065	3,249

TABLE 5-11 (continued)

Pollutant Category and Pollutant	Combined Average Raw Waste Load[1]	
	Day 1 (μg/ℓ)	Day 2 (μg/ℓ)
iron	78,018	35,972
lead*	2,457	5,448
magnesium	14,716	12,513
manganese	1,186	654
molybdenum	499	177
nickel*	1,080	360
sodium	331,763	312,252
tin	349	296
titanium	337	300
vanadium	32	57
zinc*	7,331	6,603
antimony*	138	126
arsenic*	87	--
mercury*	2.9	2.6
selenium*	251	--
silver*	34	38
Cyanide		
cyanide, total*	0.031	0.037
Other Pollutants	(mg/ℓ)	(mg/ℓ)
residue, filterable	1,500	4,503
residue, non-filterable	1,894	1,551
fluoride	10	NR
ammonia, as N	1.8	1.0
nitrogen, kjeldahl, total	52	13
nitrate-nitrite, as N	0.72	0.90
total phosphorus, as P	5.9	54
BOD-5 day (carbonaceous)	1,015	1,265
chemical oxygen demand	5,002	5,719
oil and grease total recoverable	1,459	2,388
total organic carbon	414	636
sulfide, total (iodometric)	NR	3.9

---

[1] These values are flow weighted average pollutant concentrations based on the concentrations listed in Table 5-12 for uniform washers stream and towel washers stream and the long-term average flows for each stream. The uniform washers stream flow equals 29,200 GPD and the towel washers stream flow equals 11,700 GPD. The combined average raw wasteload concentration for Pollutant A is given by the formula:

$$\frac{(\text{concentration A - Uniforms})(29{,}200)+(\text{concentration A - towels})(11{,}700)}{40{,}900}$$

* Priority Pollutant

TABLE 5-12

ITD/RCRA SAMPLING PROGRAM
SUMMARY OF REPORTED ANALYTICAL RESULTS
PLANT E

Pollutant Category and Pollutant	Final Effluent (μg/ℓ)
Volatile Organic Compounds	
acetone	1542
chloroform*	10
ethylbenzene*	177
tetrachloroethene*	213
toluene*	548
trichloroethene*	15
1,1,1-trichloroethane*	478
2-butanone	427
Semi-Volatile Organic Compounds	
bis (2-ethylhexyl) phthalate*	1192
isophorone*	690
n-decane	394
n-dodecane	180
n-eicosane	159
n-hexadecane	162
n-octadecane	115
n-tetradecane	85
naphthalene*	40
Metals	
antimony*	121
arsenic*	5
cadmium*	25
chromium*	261
copper*	487
lead*	400
mercury*	0.8
zinc*	1960
barium	429
lithium	26
iron	13,000
nickel	106
strontium	420
Cyanide	
cyanide, total*	0.04c
Conventional Pollutants	(mg/ℓ)
residue, non-filterable	464
BOD-5 Day (carbonaceous)	222
Nonconventional Pollutants	
chemical oxygen demand	1,520
fluoride	1.2
nitrate-nitrite, as N	0.27
total organic carbon	353
ammonia, as N	1.02

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* Priority pollutant

c Average of grab sample results

TABLE 5-13

SUMMARY OF POLLUTANT CONCENTRATIONS IN INDUSTRIAL LAUNDRY WASTEWATERS OBTAINED FROM THE MASSACHUSETTS WATER RESOURCES AUTHORITY

Pollutant	Number[1]	Maximum Concentration (mg/ℓ)	Median Concentration (mg/ℓ)	Mean Concentration (mg/ℓ)
Organics				
1,1,1-trichloroethane*	3/2	0.30	0.021	0.11
ethylbenzene*	9/5	6.000	1.05	1.950
methylene chloride*	2/1	1.4	0.075	0.075
naphthalene*	6/4	0.75	0.26	0.33
N-nitrosodiphenylamine*	3.2	0.30	0.100	0.146
bis(2-ethylhexyl) phthalate*	9/5	42.00	1.10	1.460
butyl benzyl phthalate*	7/4	0.280	0.14	0.141
di-n-butyl phthalate*	6/3	0.590	0.155	0.197
tetrachloroethene*	7/6	90.0	0.070	13.7
toluene*	7/6	24	1.90	5.16
acetone	3/2	4.4	0.76	1.89
benzyl alcohol	2/2	0.53	0.53	0.53
benzoic acid	1/1	0.022	0.022	0.022
petroleum hydrocarbons	10/4	600.000	87.000	152.000
2-methylnaphthelene	6/4	0.200	0.058	0.092
phenanthrene*	2/2	0.020	0.015	0.015
chlorobenzene*	2/2	5.30	2.80	2.80
chloroform*	1/1	0.01	0.01	0.01
trans-1,2-dichloroethene*	1/1	0.08	0.08	0.08
Metals				
aluminum	4/1	0.0092	0.006	0.006
antimony*	3/2	0.047	0.006	0.019
arsenic*	3/2	0.055	0.012	0.025
cadmium*	9/3	0.120	0.020	0.036
chromium*	10/4	0.39	0.071	0.127
chromium(+6)	2/1	0.9	0.49	0.49
copper*	11.4	4.20	0.060	0.086
lead*	11/4	2.30	0.48	0.690
mercury*	7/4	0.0086	0.00040	0.0016
nickel*	9.4	0.190	0.080	0.095
selenium*	3/2	0.024	0.006	0.011
silver*	1/1	0.030	0.030	0.030
zinc*	11/4	7.40	1.40	1.95
Conventional Pollutants				
residue, nonfilterable	10/6	944	205	338
BOD-5 day	11/5	2610	501	623
oil & grease	15/6	1800	419	542
Nonconventional Pollutants				
volatile solids	5/4	1070	493	643

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[1] Ratio indicates the number of samples in which the specific pollutant was found compared to the total number of facilities at which pollutant was detected.

TABLE 5-14

SUMMARY OF REPORTED ANALYTICAL RESULTS FROM THREE LAUNDRIES DISCHARGING TO A NEW YORK STATE POTW

Pollutant Parameter	Found at No. of Facilities	Found in No. of samples[1]	Range (μg/ℓ)	Average (μg/ℓ)
benzene*	3	4/6	170-4400	2040
toluene*	2	4/6	200-9000	3900
xylenes	3	5/6	200-4000	2460
methylene chloride*	2	3/6	200-1050	830
chloroform*	2	3/6	30-900	360
1,1,1 trichloroethane*	2	2/6	20-50	35
trichloroethene	2	2/6	5-100	53
tetrachloroethene*	2	3/6	250-1200	590

---

*Priority pollutant

[1] Ratio indicates the number of samples in which pollutant was found to the total number of samples analyzed. Two samples were analyzed per facility.

TABLE 5-15

SUMMARY OF POLLUTANT CONCENTRATIONS FOUND IN INDUSTRIAL AND COMMERCIAL LAUNDRY WASTEWATERS OBTAINED FROM STATE AND LOCAL SOURCES[1]

Pollutant	Number of Samples	Average (μg/ℓ)	Minimum Value (μg/ℓ)	Maximum Value (μg/ℓ)
antimony*	7	9.4	1.0	24.0
arsenic*	4	1.7	1.0	2.0
cadmium*	19	73.8	8.0	427.0
chromium*	15	311.5	3.0	1400.0
copper*	22	675.4	40.0	3560.0
cumene	1	50.0	50.0	50.0
cyanide*	4	235.7	10.0	900.0
lead*	37	1059.4	50.0	6600.0
mercury*	9	4673.3	290.0	32300.0
n-butyl alcohol	1	275.0	275.0	275.0
nickel*	19	181.6	30.0	950.0
phenol*	7	8115.7	100.0	24800.0
selenium*	3	5.0	3.0	8.0
silver*	8	19.7	3.0	86.0
xylene	2	275.0	50.0	500.0
zinc*	24	1629.3	100.0	10000.0
flow (MGD)	17	0.0305	0.005	0.085

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[1] Source of data: Appendix I of The Domestic Sewage Study.

pollutants and a small number of common, toxic metals. Some POTWs are beginning to recognize the possibility that organic pollutants may cause problems, but as yet most are unwilling to incur the expense of a complete analyses for all priority pollutants. Nonetheless, some organics data have been obtained from local sources, however. The Massachusetts Water Resources Authority (MWRA) has required extensive sampling and analyses of wastewater discharged to its sewers by industrial users. MWRA has had the effluent from five industrial laundries within its jurisdiction analyzed for the entire list of priority pollutants plus some classical pollutants. The sampling occurred between April 1982 and November 1985, and appears to include most but not all of the major dischargers (more than 10,000 gallons per day). No data have been obtained for a number of laundries, most of which are apparently minor dischargers. A limited amount of data was obtained for one small laundry. Analyses have been obtained for six industrial laundries and are summarized in Table 5-13. The data for the individual laundries are presented in Appendix C.

In addition to the Massachusetts data, a POTW in New York State has provided the Agency with data from the three industrial laundries within its jurisdiction. The wastewater from these laundries were analyzed for purgeable halocarbons and purgeable aromatics plus some conventional and nonconventional pollutants. These analyses were made annually for the past several years. (This document contains data collected in 1983 and 1984.) These data may not be typical as they were collected because the sanitary district considered the waste effluents from at least one of these laundries were a problem. The organics data from these laundries are summarized in Table 5-14. Data for the individual laundries are presented in Appendix C.

During the course of the Domestic Sewage Study, a number of state and local agencies were contacted to obtain toxic pollutant data and other relevant information. Information so obtained, concerning the laundries industry, is summarized in Section 3 and Appendix I of the Domestic Sewage Study (1). A summary of the pollutant concentrations is presented in this document in Table 5-15.

SECTION 6

6.0 POLLUTANT PARAMETERS

The conventional, nonconventional, and priority, pollutants that characterize industrial laundry wastewater were shown in Section 5. The most prevalent of these pollutants are examined in this section to determine, if possible, which may present problems, either in wastewater or sludges. These pollutant groups are defined in Section 5.0. In addition, the total pollutant discharge by the industry is estimated.

The priority and nonconventional pollutant groups discussed in the following sections and presented in associated tables are divided, for convenience, into the following subgroups.

- volatile organic compounds
- semi-volatile organic compounds
- pesticides and herbicides
- metals and elements
- miscellaneous pollutants

The reader should note that, except as specifically defined otherwise in Section 6.4, references to average concentrations of a specific pollutant mean the sum of all concentrations of that pollutant found in raw waste streams, during the 1986-1987 sampling episode, divided by the number of samples that were analyzed for that pollutant.

6.1 Conventional Pollutants

The Clean Water Act of 1977 required the Administrator to establish effluent limitations and standards for conventional pollutants. The conventional pollutants, biochemical oxygen demand (BOD), total suspended solids (TSS), pH, and oil and grease were considered for regulation but none were found to be such specific and persistent pollution problems across the laundries industry to warrant rulemaking efforts. The industry was exempted from regulation under paragraph 8 of the consent decree.

The aforementioned conventional pollutant parameters were identified in all plant effluents for which data were obtained in both the past and recent sampling episodes. Pollutant levels for these parameters in raw waste and treatment effluent streams are frequently high. Conventional pollutant raw waste data collected during the recent ITD/RCRA sampling program are summarized in Table 6-1. These results can be compared to results from previous sampling programs presented in Table 5-3. As can be seen, the two data sets are in close agreement.

6.2 Priority Pollutants

Because of the diversity of materials laundered by the industry, many priority pollutants may be present in the raw wastewater of a plant. Table 5-4 presents information on the occurrence,

TABLE 6-1

SUMMARY OF CONVENTIONAL POLLUTANT CONCENTRATIONS IN INDUSTRIAL LAUNDRY WASTEWATERS ITD/RCRA SAMPLING PROGRAM

Pollutant	Number[1]	Minimum Concentration (mg/ℓ)	Maximum Concentration (mg/ℓ)	Median Concentration (mg/ℓ)	Mean Concentration (mg/ℓ)
BOD$_5$	9/9	222	1,900	1,015	1,120
TSS	9/9	464	1,894	930	1,041
oil and grease	8/8	140	2,388	880	1,001
pH (standard units)	6/6	9.2	12.2		

---

[1] Ratio indicates the number of samples in which the specific pollutant was found as compared to the total number of samples analyzed.

frequencies, and levels of priority pollutants found in samples collected by EPA in the 1978 screening/verification program and Table 6-2 presents similar information from the current ITD/RCRA sampling program. A comparison of the data shown in the tables demonstrates the variability found in the wastewaters generated by the industry. The results of the analyses for pollutants in the different pollutant categories are discussed in the following sections.

6.2.1 ITD/RCRA Sampling and Analysis Program-Wastewater Samples

Volatile Organics - Twelve volatile organic priority pollutants were detected one or more times in the wastewaters from the five laundries sampled during the ITD/RCRA sampling program. Only seven of these compounds had been detected in laundry wastewater during the earlier screening/verification program, reflecting the variability of the industry's wastewaters due in part to the diversity of the industry's products.

Five compounds were found relatively frequently and at relatively high average concentrations (mg/l range or above) during the present study. The compounds, ethylbenzene, methylene chloride, tetrachloroethene, toluene, and 1,1,1-trichloroethane, are common industrial solvents. All of these, except the last, were found at approximately the same high frequency and levels during the 1978 study. Although benzene and chloroform had been found frequently and at high levels during the earlier study, only chloroform was detected during the current study (once, at a very low concentration). All other compounds detected during either study were found infrequently and at low average concentrations.

Semi-volatile Organics - Ten semi-volatile organic priority pollutants were detected one or more times during the ITD/RCRA program. Seven of these had been detected in the earlier study. Three compounds, isophorone, naphthalene, and N-nitrosodi-n-propylamine, were found more than twice and at relatively high average concentrations. Of these, only naphthalene had been detected frequently during the earlier study. One compound, bis(2-ethylhexyl)phthalate, had been found frequently during the screening/verification program but was found less frequently and at a lower average level during the ITD/RCRA program. All other compounds detected during either study were found infrequently and at low average concentrations.

Pesticides and Herbicides - Although no priority pollutant pesticides or herbicides were detected during the 1978 study, four were detected once or twice during the ITD/RCRA program. Only one compound, endosulfan sulfate, was found at a relatively high concentration (1.4 mg/l).

Metals - All priority pollutant metals were detected in laundry wastewater, and most were detected in over half the samples analyzed. Only beryllium, selenium, and thallium (which was not analyzed for quantitatively) were detected in less than half the samples. Copper, lead, and zinc were found at concentrations over 1 mg/l The relative frequencies of detection and the levels

TABLE 6-2
SUMMARY OF PRIORITY POLLUTANT DATA FROM INDUSTRIAL LAUNDIRES RAW WASTEWATER ITD/RCRA SAMPLING PROGRAM

Pollutant Category and Pollutant	Total Number of Samples	Total Number of Detected Analyses	Concentration Range (μg/ℓ)	Average Concentration (μg/ℓ)	Median (μg/ℓ)
Volatile Organic Compounds					
chlorobenzene	9	1	41	5	0
2-chloroethylvinyl ether	9	1	31	3	0
chloroform	9	1	10	1	0
1,1-dichloroethane	9	1	24	3	0
1,1-dichloroethene	9	1	311	35	0
trans-1,2-dichloroethene	9	2	10-204	24	0
ethylbenzene	9	8	46-12,396	2,825	183
methylene chloride	9	6	21-12,255	1,450	41
tetrachloroethene	9	6	58-15,947	2,039	213
toluene	9	8	97-10,292	2,591	548
1,1,1-trichloroethane	9	4	73-10,965	1,302	0
trichloroethene	9	3	15-204	26	0
Semi-volatile Organic Compounds					
benzidine	9	1	6,418	713	0
bis(2-ethylhexyl)phthalate	9	3	112-3,443	527	0
di-n-octyl phthalate	9	1	21	2	0
isophorone	9	4	32-8,217	998	0
naphthalene	9	3	40-12,963	1,659	0
nitrosobenzene	9	1	38	4	0
N-nitrosodiphenylamine	9	1	39	4	0
N-nitrosodi-n-propylamine	9	3	850-14,945	2,174	0
phenanthrene	9	1	19	2	0
2-chloronaphthalene	9	2	206-4,403	512	0
Pesticides/Herbicides					
aldrin	8	2	0.8-7.1	1	0
endosulfan sulfate	8	2	74-1,377	181	0
BHC, alpha	7	1	10.4	1	0
heptachlor	8	1	24.2	3	0
Metals					
antimony	9	9	20-138	75	60
arsenic	9	7	5-87	16	7.6
berylium	9	4	1.4-4.0	1	0
cadmium	9	9	25-426	131	66
chromium	9	9	185-835	453	424
copper	9	9	487-4,065	2,021	1,630
lead	9	9	400-7,735	3,108	2,850
mercury	9	8	0.7-2.9	1	1.2
nickel	9	9	67-1,080	276	152
selenium	9	1	251	28	0
silver	9	6	2.7-38	17	19
zinc	9	9	1,960-7,331	4,400	3,920
Cyanide					
Cyanide, total	9	9	31-17,000	2,020	170

at which they were detected during the ITD/RCRA program are approximately equal to the frequencies and levels found during the earlier screening/verification program.

Cyanide - Cyanide was detected in all the raw wastewater streams sampled during the ITD/RCRA program. It was found once at a relatively high level (17 mg/l), and several other times above 0.1 mg/l Cyanide was detected slightly less frequently and at a slightly lower average level during the earlier study.

Process chemicals used in laundering operations account for only some of the detected priority and nonconventional pollutants. The source of many of the pollutants detected in industrial laundry wastewater was the materials submitted to the laundries.

Among the process sources of pollutants at industrial laundries are soaps and detergents which contribute to BOD_5 and oil and grease loadings, zinc compounds in sours and germicides, solvents used for spot removal, phenolic compounds used in germicides, bacteriostats, dust treating compounds, detergent additives, and chlorine bleaches that can generate chlorinated hydrocarbons in wastewater.

The major source of many priority and nonconventional pollutants (including volatiles, semivolatiles, metals, and pesticides) appears to be the soiled shop towels and cloths sent for cleaning by industrial customers. Examples of contaminants which are sent to laundries in this manner are pesticides such as EPN and aldrin, semivolatiles such as naphthalene and benzidine, and volatiles such as methylene chloride, an often used degreaser. The fact that many pollutants are found infrequently and at varying concentrations is consistent with the changing nature of the materials laundered at individual facilities.

6.2.2 ITD/RCRA Sampling and Analysis Program - Solids and Sludge Samples

Sludge samples were obtained from four of the five laundries sampled during the ITD/RCRA program. Thickened sludge samples from dissolved air flotation units were obtained at laundries A and B. Settling basin sediment was obtained at one settling basin at laundry C and two basins at laundry D. In addition, several other solids samples were obtained at laundry D. These were solids from a lint screen, solids from a disc strainer, oil from an oil skimmer, and final concentrate from an ultrafilter.

Each of the sludge samples taken were analyzed for the priority pollutants. In addition, the toxicity characteristic leaching procedure (TCLP) was applied, in most cases, to the sludge samples and the TCLP extracts were also analyzed for priority pollutants. If certain pollutants are present above designated levels in the TCLP extract of a solid waste, the solid waste is said to exhibit the characteristic of toxicity. Solid wastes with this characteristic are designated hazardous wastes and must be handled and disposed of in conformance with hazardous waste regulations. The priority pollutants found in solids samples obtained at the four laundries are indicated in Table 6-3. Solids samples were not collected during the screening/verification program, and no comparisons are

TABLE 6-3
SUMMARY OF PRIORITY POLLUTANTS FOUND IN SLUDGE SAMPLES
ITD/RCRA SAMPLING PROGRAM

Pollutant Category and Pollutant	Laundry A		Laundry B		Laundry C		Regulatory Levels for TCLP (µg/ℓ)
	DAF Thickened Sludge (µg/kg)	TCLP (µg/ℓ)	DAF Thickened Sludge (µg/kg)	TCLP (µg/ℓ)	Settling Basin Sludge (µg/kg)	TCLP (µg/ℓ)	
Volatile Organic Compounds							
benzene	--	--	--	--	--	--	70(p)
bromodichloromethane	--	--	--	--	--	--	
carbon tetrachloride	--	--	--	--	--	--	70(p)
chloroform	--	--	--	--	--	--	
dibromochloromethane	--	--	--	--	--	--	70(p)
ethylbenzene	2,569	912	938	--	10,909	165	
methylene chloride	--	--	--	--	--	--	8,600(p)
tetrachloroethene	--	--	--	--	50,455	146	100(p)
toluene	4,831	116	376	33	650,727	7,327	14,400(p)
trans-1,2-dichloroethene	--	--	838	--	5,818	5,824	
trichloroethene	--	--	--	--	--	--	
1,1-dichloroethane	--	--	--	--	--	--	
1,1-dichloroethene	--	--	--	--	--	--	100(p)
1,1,1-trichloroethane	369	--	--	--	--	--	30,000(p)
1,1,2,2-tetrachloroethane	--	--	--	--	--	--	1,300(p)
Semi-volatile Organic Compounds							
anthracene	--	--	--	--	--	--	
bis(2-ethyhexyl)phthalate	--	--	--	--	850,909	17	
di-n-butyl phthalate	497	--	--	55	--	20	
butyl benzyl phthalate	397	--	9,979	--	--	--	
dimethyl phthalate	--	--	--	--	--	--	
naphthalene	179	93	--	--	--	--	
phenanthrene	--	--	--	--	--	--	
2-chloronaphthalene	114	56	--	--	--	--	
Metals							
berylium	--	--	--	--	--	--	
cadmium	36	208	31	--	30	93	1,000(f)
chromium	124	128	218	119	227	229	5,000(f)
copper	1,030	72	1,080	--	1,340	2,760	
lead	1,560	850	936	--	989	1,760	5,000(f)
nickel	39	174	102	398	296	46	
zinc	1,560	11,500	2,070	4,880	2,420	4,090	
antimony	67	--	14	50	--	45	
arsenic	31	--	36	--	17	--	5,000(f)
mercury	1.6	--	1.3	--	--	0.3	200(f)
selenium	--	--	--	--	--	--	1,000(f)
silver	4	--	49	--	6.0	17	5,000(f)

TABLE 6-3 (continued)

Pollutant Category and Pollutant	Laundry A		Laundry B		Laundry C		Regulatory Levels for TCLP (µg/ℓ)
	DAF Thickened Sludge (µg/kg)	TCLP (µg/ℓ)	DAF Thickened Sludge (µg/kg)	TCLP (µg/ℓ)	Settling Basin Sludge (µg/kg)	TCLP (µg/ℓ)	
Pesticides/Herbicides							
endosulfan sulfate	NA	NA	NA	NA	328	NA	
Cyanide							
cyanide, total	NA	NA	11	NA	6.6	NA	

TABLE 6-3 (continued)

Pollutant Category and Pollutant	Uniform Washers - Laundry D						Shop Towel Washers - Laundry D				Regulatory Levels for TCLP (µg/ℓ)
	1st Settling Basin		Shaker Screen		2nd Settling Basin		Disc Strainer		Ultrafilter Concentrate		
	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	(µg/kg)	TCLP (µg/ℓ)	
Volatile Organic Compounds											
benzene	--	--	--	--	--	--	--	--	69	NA	70(p)
bromodichloromethane	--	--	--	--	--	--	--	--	22	NA	
carbon tetrachloride	--	--	122	--	--	--	--	--	118	NA	70(p)
chloroform	--	--	--	--	--	--	--	--	142	NA	
dibromochloromethane	--	--	--	--	--	--	--	--	15	NA	70(p)
ethylbenzene	--	--	104	--	97	22	231	--	64,950	NA	
methylene chloride	100	59	396	26	--	78	--	44	7,119	NA	8,600(p)
tetrachloroethene	1,535	20	196	72	63	30	29,995	1,660	1,620,900	NA	100(p)
toluene	869	38	78	--	--	169	5,579	425	518,720	NA	14,400(p)
trans-1,2-dichloroethane	--	--	--	--	--	--	--	--	--	NA	
trichloroethene	--	--	--	--	--	22	192	101	116	NA	
1,1-dichloroethane	49	--	--	--	--	25	62	71	153	NA	
1,1-dichloroethene	--	--	--	--	--	--	--	--	15,794	NA	100(p)
1,1,1-trichloroethane	--	--	--	--	--	--	136	--	153,681	NA	30,000(p)
1,1,2,2-tetrachloroethane	--	--	--	--	--	--	--	--	343	NA	1,300(p)
Semi-volatile Organic Compounds											
anthracene	--	--	3,039	--	--	--	--	--	--	NA	
bis(2-ethyhexyl)phthalate	--	--	--	--	20,881	--	--	--	241,880	NA	
di-n-butyl phthalate	--	--	13,987	--	--	13	--	--	140,330	NA	
butyl benzyl phthalate	--	--	--	--	--	--	--	--	--	NA	
dimethyl phthalate	--	--	3,191	--	--	--	--	--	--	NA	
naphthalene	--	--	--	19	--	--	--	--	147,790	NA	
phenanthrene	--	--	4,378	--	--	--	--	--	--	NA	
2-chloronaphthalene	--	--	--	--	--	--	--	--	--	NA	
Metals											
berylium	9	--	6	--	1	--	8	--	--	--	
cadmium	106	491	13	139	99T	559	79	584	68	725	1,000(f)
chromium	4,780	39	325	75	372T	29T	923	70	38	23	5,000(f)
copper	53,200	170	5,080	398	2,550	180T	8,790	88	520	1,060	
lead	4,770	137	640	457	1,100	1,200T	1,700	1,140	2,890	5,750	5,000(f)
nickel	4,150	1,240	225	313	541	2,900	1,120	2,080	43	466	
zinc	12,600	15,700	1,520	5,990	2,090	20,200	3,110	22,600	1,480	2,180	
antimony	44	--	16	--	23R	--	34	22S+	41	40	
arsenic	2S	--	5S+	--	--	--	--	--	--	--	5,000(f)
mercury	0.5	--	--	0.3	1.1	--	0.9	--	0.1	--	200(f)
selenium	1	--	--	--	2T	--	1	--	3T	--	1,000(f)
silver	417	--	17	--	145	--	85	--	8.0	--	5,000(f)

TABLE 6-3 (continued)

Pollutant Category and Pollutant	Uniform Washers - Laundry D						Shop Towel Washers - Laundry D				Regulatory Levels for TCLP (µg/ℓ)
	1st Settling Basin		Shaker Screen		2nd Settling Basin		Disc Strainer		Ultrafilter Concentrate		
	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	(µg/kg)	TCLP (µg/ℓ)	
Cyanide											
cyanide, total	2.2	NA	--	NA	--	NA	3.1	NA	600	NA	
Pesticides/Herbicides											
endosulfan sulfate	--	NA	--	NA	2,378	NA	--	NA	--	NA	

--	Indicates pollutant concentration below detection limit
NA	Indicates not analyzed
S	Indicates value determined by Method of Standard Addition
+	Indicates the correlation coefficient for Method of Standard Addition is less than 0.995
R	Indicates spike recovery is not within control limits
T	Indicates duplicate analysis is not within control limits
(f)	Final rules for EP Toxicity Characteristic, see 40 CFR 261 Subpart C
(p)	Proposed rules for Toxicity Characteristic, see 51 FR 21648
TCLP	Toxicity characteristic leaching procedure

possible. The sludge analyses and the TCLP extract analyses are also presented in Table 6-3[2]. Table 6-3 presents final and proposed hazardous waste identification regulations (regulatory levels) as defined by the Resource Conservation and Recovery Act (RCRA) for TCLP extracts, for the pollutants to which the regulations are applicable. The pollutants found in each of the pollutant groups are discussed briefly in the following paragraphs.

Volatile Organics - Fourteen volatile organic priority pollutants were detected one or more times in the various sludges sampled, a number at levels higher than 1 mg/kg. The TCLP extracts of these samples contained most of the same compounds usually at low levels. Two samples exceeded the proposed regulatory level for tetrachloroethene. One of these, the sludge from a disc strainer for shop towel wastewater at laundry D is treated as a hazardous waste. We do not believe that the other, sediment from a settling basin at laundry C, is handled as a hazardous waste.

Semi-volatile Organics - Eight semi-volatile organic priority pollutants were detected in one or more sludge samples, some at levels above 1 mg/kg. TCLP extracts for these samples contained the same pollutants at low levels. No compounds were found for which final or proposed regulatory levels for the TCLP extracts exist.

Metals - Twelve of the thirteen priority pollutant metals were found in the sludge samples. All samples contained at least half of the metals. Copper, lead, nickel and zinc were frequently found at relatively high concentrations. Most metals were also found in the TCLP extract, several at relatively high concentrations. The ultrafilter concentrate was the only sludge sample with TCLP extract containing any metal at a concentration above the regulatory level. Lead was found in the concentrate extract at 5,750 g/kg and the regulatory level is 5,000 g/kg. The concentrate, which by its nature contains high levels of many other pollutants, is treated as a hazardous waste. Cadmium was found in the TCLP extract of several samples at levels less than, but approaching, the regulatory levels.

Cyanide - Cyanide was found at relatively low levels (2.2 to 11 μg/l) in all of the sludge samples except one in which it was not detected, and the ultrafilter concentrate in which it was found at a higher concentration (600 μg/l). The TCLP extracts were not analyzed for cyanide.

Pesticides and Herbicides - One priority pollutant pesticide, endosulfan sulfate, was found in two solids samples, once at approximately 1 mg/kg. The TCLP extracts were not analyzed for pesticides and herbicides. There are, however, no regulations applicable to the compound found.

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[2] The analyses of the oil sample from the oil skimmer are not presented in Table 6-3, Table 6-5 or discussed in the following text because analyses of the TCLP extract were not performed. The oil analyses are presented in Table 5-10. The oil is disposed of by incineration.

6.3 Nonconventional Pollutants

To obtain a more complete characterization of industrial laundries wastewater than was obtained during earlier studies, an expanded list of pollutants was analyzed for (see Table 5-2). The nonconventional pollutants found at high frequency or relatively high concentrations are discussed briefly in this section.

6.3.1 ITD/RCRA Sampling and Analysis Program - Wastewater Samples. The nonconventional pollutants listed in the "1987 ITD List of Analytes" and found in the raw wastewaters of the five laundries sampled are presented in Table 6-4.

Miscellaneous Pollutants - The Clean Water Act of 1977 required the Administrator to establish effluent limitations and standards for several nonconventional pollutants. Chemical oxygen demand (COD), total organic carbon (TOC), ammonia, nitrogen, and phosphorus were considered for regulation but none were previously found to be such specific and persistent pollution problems across the laundries industry to warrant rulemaking efforts. The industry was exempted from regulation under paragraph 8 of the consent decree.

Most of the aforementioned pollutants were identified in all plant effluents for which data were obtained in both the past and recent sampling episodes. Pollutant levels for these parameters in raw waste and treatment effluent streams are frequently high. Miscellaneous nonconventional pollutant raw waste data collected during the recent ITD/RCRA sampling program and summarized in Table 6-4 can be compared to results from previous sampling programs presented in Table 5-3. As can be seen, the two data sets are in close agreement.

Volatile Organics - Four hazardous nonconventional pollutant volatile organic compounds were detected in laundry raw wastewaters. Of these, acetone was found in all the samples, sometimes at significant levels (15 mg/l to 1 gm/l). 2-butanone was found in two samples, once at 16 mg/l Both are common industrial solvents. The remaining compounds were found once each at low concentrations.

Semi-volatile Organics - Fourteen hazardous nonconventional pollutant semi-volatile organic compounds were detected in laundry raw wastewaters. Eight of these compounds were detected in only one or two samples each and found at low overall average concentrations although some were found at an individual facility at relatively high concentrations. The remaining six compounds were found at higher frequencies and at relatively high average concentrations (0.7 to 5 mg/l). These compounds, all straight chain hydrocarbons with a variety of industrial uses, are n-decane, n-dodecane, n-tetradecane, n-hexadecane, n-octadecane, and n-eicosane.

TABLE 6-4
SUMMARY OF NONCONVENTIONAL POLLUTANT DATA FROM INDUSTRIAL LAUNDRIES WASTEWATER ITD/RCRA SAMPLING PROGRAM

Pollutant Category and Pollutant	Total Number of Samples	Total Number of Detected Analyses	Concentration Range (µg/ℓ)	Average Concentration (µg/ℓ)	Median (µg/ℓ)
Volatile Organic Compounds					
acetone	9	9	101-1,373,430	156,980	1,701
2-butanone	9	2	427-16,762	1,910	0
isobutyl alcohol	8	1	138	17	0
vinyl acetate	8	1	14	2	0
Semi-volatile Organic Compounds					
alpha terpineol	9	2	199-5219	602	0
biphenyl	9	3	11-1,766	201	0
p-cymene	9	3	84-3,464	652	0
diphenylamine	9	1	36	4	0
n-decane	9	4	394-34,154	5,238	0
n-dodecane	9	4	180-8,218	1,545	0
n-eicosane	9	2	159-2,515	297	0
n-hexadecane	9	4	94-4,994	677	0
2-methylnaphthalene	8	2	112-186	37	0
n-octadecane	9	3	115-6,319	740	0
n-tetradecane	9	5	21-18,615	3,399	21
n-tetracosane	9	2	1,379-8,351	1,081	0
n-docosane	9	1	6,391	710	0
styrene	9	1	102	11	0
Pesticides/Herbicides					
dioxathion	7	1	565	81	0
azinphos ethyl	7	1	278	40	0
EPN	8	1	1,582	198	0
etridazone	7	1	15	2	0
phosmet	7	1	28	4	0
tetrachlorovinphos	8	1	692	87	0
Metals					
aluminum	8	8	1,900-10,600	6,905	6,447
barium	9	9	429-1,857	1,113	1,390
boron	8	8	242-894	569	546
calcium	8	8	11,000-168,000	47,251	33,100
cobalt	9	6	80-345	151	127
iron	9	9	3,100-78,018	30,088	20,200
magnesium	8	8	2,400-35,000	11,565	9,175
manganese	8	8	100-1,186	546	373
molybdenum	8	7	102-499	224	196
sodium	8	8	249,000-1,310,000	587,377	529,500
tin	8	7	47-349	177	207
titanium	8	8	48-337	205	220
vanadium	9	6	7-57	18	10
Miscellaneous Pollutants			(mg/ℓ)	(mg/ℓ)	(mg/ℓ)
residue, filterable	8	8	1,000-4,800	2,825	2,800
TOC	9	9	353-1,100	669	636
fluoride	8	8	1.2-39	19.8	18
phosphorus	8	8	5.9-54	32	35
chemical oxygen demand	9	9	1,520-6,100	4,660	4,900
ammonia (as N)	9	5	1.0-1.8	0.68	1.0
nitrogen, Kjeldahl	9	9	0.27-52	19.4	14
nitrate-nitrite	8	8	0.21-1.5	0.85	0.81
sulfide, total (iodometric)	7	7	1.3-5.9	3.8	3.9

Herbicides and Pesticides - Six nonconventional pollutant herbicides and pesticides were detected in laundry raw wastewaters during the ITD/RCRA sampling program. All were detected only once but three (dioxathion, etriadazone, and tetrachlorovinphos) were found at relatively high levels (>1/2 mg/l).

Metals and Elements - A wide variety of metals and elements, both hazardous and non-hazardous, were quantitatively or qualitatively analyzed for (see Tables 5-6 through 5-12). The hazardous nonconventional pollutant metals and non-hazardous metals (included here for convenience) are presented in Table 6-4 and discussed here. All the metals detected in laundry raw wastewaters were detected in at least two-thirds of the samples, and most in all the samples.

Sodium, calcium, iron, and magnesium were found at relatively high average concentrations (10 mg/l to 600 mg/l). Aluminum and barium were found at average concentrations over 1 mg/l and boron and manganese at average concentrations of over 0.5 mg/l The remainder, although detected frequently, were found at relatively lower concentrations.

6.3.2 ITD/RCRA Sampling and Analysis Program - Solids and Sludge Samples. The solids and sludge samples obtained at four industrial laundries were analyzed for the nonconventional pollutants listed in the "1987 ITD List of Analytes". The sources of the samples obtained are discussed in detail in Section 5 of this document and summarized in this section under the discussion of priority pollutants (Section 6.2.2).

In addition to the sludge analyses, the TCLP extract from most sludge samples were analyzed for the same pollutants. These analyses were used to determine whether the solids exhibited the hazardous waste characteristic of toxicity. Several other solids-specific pollutant parameters were also analyzed for to determine whether the solids exhibited any hazardous waste characteristics other than toxicity. Other characteristics directly determined were ignitability (flash point less than 60°C), and corrosivity (soil pH of less than 2 or greater than 12.5 or corrosion of steel at a rate greater than 250 mil per year). A fourth characteristic of hazardous solids, reactivity, was not directly determined.

The pollutants detected in the solids samples and the solids-specific pollutant parameters, are presented by pollutant group in Table 6-5 and discussed briefly in the following paragraphs.

Volatile Organics - Six volatile hazardous nonconventional pollutant organic compounds were detected in the solid wastes sampled. Of these only acetone was detected more than once or twice in either the sludges or the TCLP extracts. There are no applicable regulatory levels in effect or proposed for any of the compounds detected.

TABLE 6-5
SUMMARY OF NONCONVENTIONAL POLLUTANTS, AND SOLID WASTE CHARACTERISITICS FOUND IN SLUDGE SAMPLES
ITD/RCRA SAMPLING PROGRAM

Pollutant Category and Pollutant	Laundry A		Laundry B		Laundry C		Regulatory Levels for TCLP (µg/ℓ)
	DAF Thickened Sludge (µg/kg)	TCLP (µg/ℓ)	DAF Thickened Sludge (µg/kg)	TCLP (µg/ℓ)	Settling Basin Sludge (µg/kg)	TCLP (µg/ℓ)	
Volatile Organic Compounds							
acetone	--	--	--	--	621,909	6,245	
isobutyl alcohol	--	--	--	--	4,000	85	
methacrylonitrile	--	--	--	--	--	--	
p-dioxane	--	--	--	--	--	--	
2-butanone	--	--	--	--	--	--	
2-hexanone	--	--	359	--	--	--	
Semi-volatile Organic Compounds							
alpha terpineol	--	67	--	--	--	--	
biphenyl	79	--	--	--	--	--	
n-decane	--	--	--	17	--	--	
n-docosane	--	--	--	24	--	--	
n-dodecane	--	33	--	--	--	--	
n-eicosane	--	48	--	--	--	--	
n-hexacosane	--	--	--	--	--	--	
n-hexadecane	--	--	20,793	20	--	--	
n-octadecane	--	--	--	--	--	--	
n-tetradecane	--	35	--	--	--	--	
p-cymene	--	--	--	--	1,285	--	
styrene	--	--	--	--	--	--	
2,6-dinitrotoluene	--	--	--	47	--	--	
Pesticides/Herbicides							
tetrachlorovinphos	NA	NA	NA	NA	--	NA	
leptophos	NA	NA	NA	NA	--	NA	
EPN	NA	NA	NA	NA	--	NA	
coumophos	NA	NA	NA	NA	--	NA	
phosmet	NA	NA	NA	NA	--	--	
Metals							
aluminum	2,040	1,350	3,750	2,110	5,020	7,900	
barium	929	1,930	701	116	639	967	100,000(f)
cobalt	178	1,620	148	1,340	--	68	
iron	6,700	701	19,599	5,200	34,500	35,900	
magnesium	1,950	9,670	8,000	27,800	4,040	6,490	
manganese	179	1,100	311	1,760	396	874	
tin	67	--	159	--	232	335	
vanadium	--	--	--	--	--	--	

TABLE 6-5 (continued)

Pollutant Category and Pollutant	Laundry A		Laundry B		Laundry C		Regulatory Levels for TCLP (µg/ℓ)
	DAF Thickened Sludge (µg/kg)	TCLP (µg/ℓ)	DAF Thickened Sludge (µg/kg)	TCLP (µg/ℓ)	Settling Basin Sludge (µg/kg)	TCLP (µg/ℓ)	
Miscellaneous Pollutants							
ammonia, as N	140	NA	420	NA	7.0	NA	
Solid Waste Characteristics							
flash point	60°C	NA	57°C	NA	60°C	NA	<60°C(f)
pH, soil	9.8	NA	7.3	NA	10.2	NA	≤2;≥12.5(f)
residue, total	29%	NA	29%	NA	11%	NA	
residue, total volatile	68%	NA	57%	NA	5%	NA	
sulfide, total (Monier-Williams)	78 mg/ℓ	NA	1,100 mg/ℓ	NA	10	NA	
Corrosivity (mpy)	<10	NA	<10	NA	<10	NA	>250(f)

TABLE 6-5 (continued)

Pollutant Category and Pollutant	Uniform Washers - Laundry D						Shop Towel Washers - Laundry D				Regulatory Levels for TCLP (µg/ℓ)
	1st Settling Basin		Shaker Screen		2nd Settling Basin		Disc Strainer		Ultrafilter Concentrate		
	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	(µg/kg)	TCLP (µg/ℓ)	
Volatile Organic Compounds											
acetone	2,900	705	--	179	1,772	1,298	--	1,314	--	NA	
isobutyl alcohol	--	--	--	--	--	--	--	--	--	NA	
methacrylonitrile	--	--	--	--	--	--	--	--	109	NA	
p-dioxane	--	--	--	--	--	--	--	--	75,785	NA	
2-butanone	--	56	--	--	--	78	--	--	--	NA	
2-hexanone	--	--	--	--	--	--	--	--	--	NA	
Semi-volatile Organic Compounds											
alpha terpineol	--	--	--	--	--	--	--	31	146,470	NA	
biphenyl	--	--	--	--	--	--	--	--	--	NA	
n-decane	--	--	--	--	--	--	10,374	--	1,618,540	NA	
n-docosane	--	--	--	--	--	--	--	--	--	NA	
n-dodecane	--	--	--	--	--	--	--	--	496,320	NA	
n-eicosane	--	--	--	--	--	--	--	--	--	NA	
n-hexacosane	--	--	40,335	--	--	--	--	--	--	NA	
n-hexadecane	--	--	28,330	--	--	--	8,867	--	--	NA	
n-octadecane	--	--	35,813	--	--	--	--	--	217,380	NA	
n-tetradecane	--	--	--	--	--	--	--	--	--	NA	
p-cymene	--	--	--	--	--	--	--	--	--	NA	
styrene	--	--	3,822	--	--	--	--	--	--	NA	
2,6-dinitrotoluene	--	--	--	--	--	--	--	--	--	NA	
Pesticides/Herbicides											
tetrachlorovinphos	--	NA	--	NA	--	NA	--	NA	825	NA	
leptophos	--	NA	--	NA	--	NA	--	NA	1,065	NA	
EPN	--	NA	--	NA	--	NA	22,241	NA	--	NA	
coumaphos	--	NA	--	NA	--	NA	17,168	NA	--	NA	
phosmet	--	NA	--	NA	--	--	--	NA	1,921	NA	
Metals											
aluminum	452,000	671	14,200	1,180	7,590	3,040	16,900	292	1,350	1,250	
barium	1,090	599	177	651	572R	1,490	331	1,110	340	4,640	100,000(f)
cobalt	309	183	25	78	59R	483	153	590	36	396	
iron	921,000	280,000	36,800	56,700	57,200T	99,100	83,900	359,000	4,400	1,650	
magnesium	59,900	4,640	5,550	4,350	8,450	18,000T	3,900	5,860	1,500	14,300	
manganese	3,420	3,860	329	1,080	460	3,810	606	4,210	130	1,760	
tin	997	--	303	--	154	--	248	--	46	--	
vanadium	239	--	22	--	243T	--	60	--	--	--	

TABLE 6-5 (continued)

Pollutant Category and Pollutant	Uniform Washers - Laundry D						Shop Towel Washers - Laundry D				Regulatory Levels for TCLP (µg/ℓ)
	1st Settling Basin		Shaker Screen		2nd Settling Basin		Disc Strainer		Ultrafilter Concentrate		
	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	Solids (µg/kg)	TCLP (µg/ℓ)	(µg/kg)	TCLP (µg/ℓ)	
Miscellaneous Pollutants											
ammonia, as N	--	NA	120	NA	830	NA	--	NA	33	NA	
Solid Waste Characteristics											
flash point	32°C	NA	42°C	NA	30°C	NA	52°C	NA	NA	NA	<60°C(f)
pH, soil	8.8	NA	8.1	NA	7.5	NA	9.9	NA	NA	NA	≤2;≥12.5(f)
residue, total	49%	NA	23%	NA	32%	NA	39%	NA	NA	NA	
residue, total volatile	3.9%	NA	20%	NA	31%	NA	26%	NA	NA	NA	
sulfide, total (Monier-Williams)	110	NA	87	NA	330	NA	150	NA	NA	NA	
Corrosivity (mpy)	--	NA	--	NA	--	NA	--	NA	NA	NA	>250(f)

* Priority Pollutant
-- Indicates pollutant concentration below detection limit
NA Indicates not analyzed
R Indicates spike recovery is not within control limits
T Indicates duplicate analysis is not within control limits
(f) Final rules for EP Toxicity Characteristic, see 40 CFR 261 Subpart C
(p) Proposed rules for Toxicity Characteristic, see 51 FR 21648
TCLP Toxicity characteristic leaching procedure

Semi-volatile Organics - Fifteen semi-volatile hazardous nonconventional organic compounds were detected in the solid wastes were detected in the solid wastes or the corresponding TCLP extracts. All were detected infrequently and most at low levels (except several were found at high levels in the ultrafiltrate concentrate). None were found in the TCLP extract at levels above 70ug/l, although it is important to note that the ultrafilter concentrate TCLP extract was not analyzed for organics. The concentrate is disposed of as a hazardous waste. There are no applicable regulatory levels for the semi-volatile organic pollutants detected in these samples.

Pesticides and Herbicides - Five pesticides or herbicides were detected in solids generated by laundering shop towels at Laundry D. Two, EPN and Coumaphos, were found at about 20 mg/kg in the disc strainer sludge. Three others, tetrachlorovinphos, leptophos, and phosmet were found at 1 to 2 mg/kg in the ultrafilter concentrate. TCLP extracts were not analyzed for these compounds for which there are no direct regulations in effect or proposed.

Metals - Each of the eight metals listed in Table 6-5 were detected in most of the sludges sampled and in most of the corresponding TCLP extracts. All, except tin and vanadium were found, at least once, at relatively high levels in the sludges and in the extracts. Of the eight metals, regulatory levels have been established only for barium, which was detected at levels well below the regulatory levels in all TCLP extracts.

Solid Waste Characteristics - The solid waste characteristics of toxicity, corrosivity, and ignitability were determined for all of the solids samples except the ultrafilter concentrate for which no determinations were made except toxicity for metals. Toxicity was discussed in previous paragraphs and corrosivity and ignitability are discussed here.

No sludge samples exhibited the characteristic of corrosivity, as the soil pH was within the range 2 to 12.5 and the corrosivity was less than 250 mil per year. All of the solids analyzed for ignitability at laundry D had flash points below 60°C and thus all except the disc strainer sludge show the characteristics of ignitability. The disc strainer sludge was probably a solid rather than a liquid sludge to which other criteria are applicable. The thickened DAF sludge from laundries A and B are also solid sludges and no conclusion can be drawn about them. The sludge from laundry C was a liquid sludge with a flash point of 60°C and therefore not ignitable but potentially so. The solids from laundries A and B are not disposed of as hazardous wastes and those from laundry C are believed not to be.

6.4 Industry Mass Loadings

Analytical data obtained during the current ITD/RCRA Sampling Program and during the earlier 1978 Screening Program were used to develop estimates of the annual mass pollutant discharge for the industrial laundries industry during these two periods. The estimates are discussed and compared in the following sections.

6.4.1 Annual Raw Waste Mass Loading - ITD/RCRA Program - The analytical results from the recent sampling done at Laundries A, B, C, D, and E have been used to develop an estimate of the annual mass discharge of ITD-listed pollutants from industrial laundries. Three methods were used to estimate the mass loadings. For each method, average concentrations were developed for all pollutants found at one or more facilities at concentrations above their analytical detection limits. These average concentrations were then summed in groups by the type of pollutant. The group concentrations were then used to calculate the total industry loadings using an estimate of the total industry flow.

The loadings are presented for pollutant groups rather than individual pollutants because the ITD/RCRA data base is not extensive enough to estimate individual pollutant loadings for the entire industry with confidence. The pollutant groups for which loadings have been estimated are as follows:

- volatile organic compounds
- semi-volatile organic compounds
- pesticides and herbicides
- metals and elements
- miscellaneous priority pollutants
- miscellaneous nonconventional pollutants
- conventional pollutants

The differences in the three approaches are the methods used to calculate the average concentrations of individual pollutants. The methods are as follows.

- Method A - The average concentration of each pollutant was developed assuming "not detected" observations are equal to zero. The average concentration for each pollutant was computed by summing over all detected concentrations and dividing by the number of analyses for that pollutant.

- Method B - The average concentration of each pollutant was developed assuming "not detected" observations are equal to the analytical detection limit. The average concentration for each pollutant was computed by summing over all detected concentrations plus the detection limit concentrations for all analyses at or below the detection limit, and dividing by the number of analyses for that pollutant.

- Method C - The average concentration of each pollutant was developed including only observations reported above the analytical detection limit. The average concentration for each pollutant was computed by summing over all detected concentrations and dividing by the number of analyses above the detection limits for that pollutant.

These methods were developed because, in cases where detection limits are high or where detected levels of a pollutant are not much greater than the detection limit, the interpretation of the detection limit presents a problem. A pollutant, undetected in a sample, might be present at any level between zero and the detection limit. To avoid any ambiguity, method A provides a lower limit for the over all average concentration of each pollutant and method B provides an upper limit.

Estimated industry average concentrations were developed for each pollutant detected one or more times in the raw waste streams of the five laundries sampled during the ITD/RCRA study. Average concentrations for each of the previously defined groups was calculated by summing the concentrations of all the pollutants in each group. Groups comprising both priority and nonconventional pollutants were subdivided into priority and nonconventional pollutants and average concentrations were calculated for each subgroup. This was done for each of the three averaging methods. The group and subgroup average concentrations and an estimated yearly average total flow for the industry were used to calculate an annual average mass loading for the industry for each group.

Based on data obtained during the 1977 survey of the industrial laundries industry, the average wastewater discharge is 68,000 gallons per day per laundry. There are currently approximately 1000 industrial laundries operating an average of 5 days per week and 52 weeks per year. The total yearly industry wastewater discharge is, therefore, approximately 17,680 million gallons.

The pollutants, the average concentrations determined by each of the three methods, the group priority pollutant and nonpriority pollutant concentrations, and the group priority pollutant and nonpriority pollutant annual mass loadings for each method are presented in Table 6-6. The annual mass loadings for each subgroup and group are summarized in Table 6-7.

These estimates of the industry's pollutant mass loadings appear reasonable within the constraints of the extremely limited amount of data available, with one possible exception. Approximately 90 percent of the volatile organics annual mass discharge is the result of a single analysis for one compound (see Table 6-6, acetone, laundry A, day 2). As each of these volatile organics analyses are based on only three grab samples taken during the course of an 8 to 10 hour work day it is possible for the results to be strongly biased by one anomalous sample. As a result the total annual discharge of volatile organics may be overestimated by a factor of ten.

6.4.2 Annual Raw Waste Mass Loadings - 1978 Screening Program - In addition to estimated industry average raw waste concentrations for the several pollutant groups based on data obtained during the 1986-87 ITD/RCRA study, additional estimates of the average concentrations were developed based on data obtained during the 1978 screening and verification sampling program. Data for the earlier program were available for conventional pollutants, priority pollutants and a small number of nonconventional pollutants (COD, phosphorus, etc.) but were not available for hazardous non-priority organic, metallic or elemental pollutants.

The estimated industry average concentrations were developed as described in Section 6.4.1 for each pollutant detected one or more times in the raw waste streams of nine industrial laundries sampled during the screening program. Individual laundry data are presented in Table 6-8. Two distinct sampling episodes occurred at two of the laundries and data are presented for each episode separately. Method B, which assumes concentrations of "not detected" observations are equal to the analytical detection limits, was not used as the analytical detection limits for these analyses are generally not available.

The pollutants, the average concentrations determined by methods A and C, the group priority and non-priority pollutant concentrations and the group priority and non-priority pollutant annual mass loadings for each method are presented in Table 6-8. The annual mass loadings for each group and subgroup are summarized in Table 6-9. The data presented in Table 6-8 were obtained from Appendix A of the 1982 Guidance Document (6) and can be found in Appendix D of this document. Annual mass loadings are based, as for the ITD/RCRA data, on an average discharge of 68,000 gallons per day per laundry by 1,000 laundries operating 5 days per week and 52 weeks per year.

TABLE 6-6

INDUSTRIAL LAUNDRIES INDUSTRY MASS LOADING ESTIMATE

COMPOUND	RAW WASTEWATER DATA									METHOD A	METHOD B	METHOD C			
PRIORITY POLLUTANTS	LAUNDRY A1	LAUNDRY A2	LAUNDRY B1	LAUNDRY B2	LAUNDRY C1	LAUNDRY C2	LAUNDRY D1	LAUNDRY D2	LAUNDRY E	AVERAGE	AVERAGE	AVERAGE	NUMBER OF SAMPLES ANALYZED	NUMBER OF DETECTS	PERCENT OF OCCURANCE
Volatile Organics (ug/l) (a)															
chlorobenzene	(10)	(10)	(10)	(10)	(10)	(10)	(100)	41	(10)	5	23	41	9	1	11%
2-chloroethylvinyl ether	(10)	(10)	(10)	(10)	(10)	(10)	(100)	31	(10)	3	22	31	9	1	11%
chloroform	(10)	(10)	(10)	(10)	(10)	(10)	(100)	(10)	10	1	20	10	9	1	11%
1,1-dichloroethane	(10)	(10)	(10)	(10)	(10)	(10)	(100)	24	(10)	3	22	24	9	1	11%
1,1-dichloroethene	(10)	(10)	(10)	(10)	(10)	(10)	311	(10)	(10)	35	43	311	9	1	11%
trans-1,2-dichloroethene	(10)	(10)	(10)	(10)	(10)	10	204	(10)	(10)	24	32	107	9	2	22%
ethylbenzene	12,396	1,304	105	913	(10)	46	10,307	183	177	2,825	2,827	3,179	9	8	89%
methylene chloride	(10)	41	38	41	21	(10)	12,255	653	(10)	1,450	1,453	2,175	9	6	67%
tetrachloroethene	(10)	(10)	58	(10)	314	843	15,947	973	213	2,030	2,042	3,050	9	6	67%
toluene	10,292	1,780	415	(10)	233	6,638	97	3,317	548	2,591	2,592	2,915	9	8	89%
1,1,1-trichloroethane	(10)	(10)	(10)	(10)	(10)	73	10,965	198	478	1,302	1,307	2,929	9	4	44%
trichloroethene	(10)	(10)	(10)	(10)	(10)	(10)	204	18	15	26	33	79	9	3	33%
Subtotal										10,303	10,416	14,858			
Estimated Mass Discharge (lb/yr)										1,520,117	1,536,838	2,192,137			
Semivolatile Organics (ug/l)															
benzidine	(5,000)	(5,000)	(50)	(50)	(5,000)	(50)	6,418	(5,000)	(50)	713	2,958	6,418	9	1	11%
bis(2-ethylhexyl)phthalate	(1,000)	(1,000)	(10)	(10)	(1,000)	112	3,443	(1,000)	1,192	527	974	1,582	9	3	33%
2-chloronaphthalene	(1,000)	(1,000)	(10)	4,403	(1,000)	(10)	206	(1,000)	(10)	512	960	2,305	9	2	22%
di-n-octyl phthalate	(1,000)	(1,000)	(10)	(10)	(10)	(10)	(1,000)	21	(10)	2	341	21	9	1	11%
isophorone	(1,000)	(1,000)	40	8,217	(1,000)	32	(1,000)	(1,000)	690	998	1,553	2,245	9	4	44%
naphthalene	(1,000)	12,963	(10)	(10)	(1,000)	(10)	1,929	(1,000)	40	1,659	1,996	4,977	9	3	33%
nitrobenzene	(1,000)	(1,000)	38	(10)	(1,000)	(10)	(1,000)	(1,000)	(10)	4	563	38	9	1	11%
N-nitrosodiphenylamine	(2,000)	(2,000)	(20)	(20)	(2,000)	39	(2,000)	(2,000)	(20)	4	1,122	39	9	1	11%
N-nitrosodi-n-propylamine	14,945	3,773	(20)	850	(2,000)	(20)	(2,000)	(2,000)	(20)	2,176	2,848	6,523	9	3	33%
phenanthrene	(1,000)	(1,000)	(10)	(10)	(1,000)	19	(100)	(10)	(10)	2	351	19	9	1	11%
Subtotal										6,597	13,666	24,167			
Estimated Mass Discharge (lb/yr)										973,270	2,016,211	3,565,528			

TABLE 6-6

INDUSTRIAL LAUNDRIES INDUSTRY MASS LOADING ESTIMATE

COMPOUND	RAW WASTEWATER DATA									METHOD A	METHOD B	METHOD C	NUMBER OF SAMPLES ANALYZED	NUMBER OF DETECTS	PERCENT OF OCCURANCE
	LAUNDRY A1	LAUNDRY A2	LAUNDRY B1	LAUNDRY B2	LAUNDRY C1	LAUNDRY C2	LAUNDRY D1	LAUNDRY D2	LAUNDRY E	AVERAGE	AVERAGE	AVERAGE			
Pesticides and Herbicides (ug/l)															
aldrin	7.1	(10.0)	0.8	(0.2)	(0.2)	(0.2)	(1.0)		(0.004)	1	2	4	8	2	25%
BHC, alpha	(10.0)	10.4	(0.2)	(0.2)	(0.2)	(0.2)	(1.0)		(0.003)	1	3	10	8	1	13%
endosulfan sulfate	(25.0)	(25.0)	(0.5)	(0.5)	(0.5)	74	1,377		(0.066)	181	188	726	8	2	25%
heptachlor	26.2	(10.0)	(0.2)	(0.2)	(0.2)	(0.2)	(1.0)		(0.003)	3	5	26	8	1	13%
Subtotal										187	198	764			
Estimated Mass Discharge (lb/yr)										27,544	29,144	112,728			
Metals (ug/l)															
antimony	20	20	60	40	30	123	138	126	121	75	75	75	9	9	100%
arsenic	7.6	10.0	12.0	7.5	(10.0)	15.0	87.0	(10.0)	5.0	16	18	21	9	7	78%
beryllium	(1.0)	2.0	2.3	1.4	(5.0)	(5.0)	(5.0)	4.0	(5.0)	1	3	2	9	4	44%
cadmium	31	72	66	42	57	284	426	179	25	131	131	131	9	9	100%
chromium	470	780	835	251	185	223	646	424	261	453	453	453	9	9	100%
copper	990	2,300	2,610	1,570	1,290	1,630	4,065	3,249	487	2,021	2,021	2,021	9	9	100%
lead	1,300	4,200	2,850	1,550	970	3,540	7,735	5,448	400	3,108	3,108	3,108	9	9	100%
mercury	1.0	1.2	1.3	0.7	2.2	(2.0)	2.9	2.6	0.8	1	2	2	9	8	89%
nickel	67	99	320	127	152	176	1,080	360	106	276	276	276	9	9	100%
selenium	(5)	(5)	(5)	(5)	(25)	(5)	251	(25)	(5)	28	37	251	9	1	11%
silver	2.7	26.0	37.0	19.0	(5.0)	(5.0)	34.0	58.0	(10.0)	17	20	26	9	6	67%
zinc	2,200	3,600	6,250	3,130	3,920	4,610	7,331	6,603	1,960	4,400	4,400	4,400	9	9	100%
Subtotal										10,529	10,545	10,767			
Estimated Mass Discharge (lb/yr)										1,553,497	1,555,841	1,588,599			
Priority Pollutant Misc. (ug/l)															
cyanide	300	230	170	210	17,000	160	31	37	40	2,020	2,020	2,020	9	9	100%
Subtotal										2,020	2,020	2,020			
Estimated Mass Discharge (lb/yr)										297,997	297,997	297,997			

TABLE 6-6

INDUSTRIAL LAUNDRIES INDUSTRY MASS LOADING ESTIMATE

COMPOUND	RAW WASTEWATER DATA									METHOD A	METHOD B	METHOD C	NUMBER OF SAMPLES ANALYZED	NUMBER OF DETECTS	PERCENT OF OCCURANCE
	LAUNDRY A1	LAUNDRY A2	LAUNDRY B1	LAUNDRY B2	LAUNDRY C1	LAUNDRY C2	LAUNDRY D1	LAUNDRY D2	LAUNDRY E	AVERAGE	AVERAGE	AVERAGE			
NONCONVENTIONAL POLLUTANTS															
Volatile Organics (ug/l) (a)															
acetone	15,831	1,373,430	493	1,840	1,701	17,457	101	463	1,542	156,984	156,984	156,986	9	9	100%
2-butanone (MEK)	(50)	(50)	(50)	(50)	(50)	16,762	(500)	(50)	427	1,910	1,999	8,595	9	2	22%
isobutyl alcohol	(1,000)	(1,000)	(10)	(10)	138	(10)	(1,000)	(1,000)	b	17	521	138	8	1	13%
vinyl acetate	(10)	(10)	(50)	(50)	14	(10)	(50)	(500)	b	2	87	14	8	1	13%
										....	....	....			
Subtotal										158,913	159,591	165,731			
Estimated Mass Discharge (lb/yr)										23,445,977	23,545,955	24,451,846			
Semi-volatile Organics (ug/l)															
alpha-terpineol	(1,000)	(1,000)	(10)	199	(1,000)	(10)	5,219	(1,000)	(10)	402	1,050	2,709	9	2	22%
biphenyl	1,766	(1,000)	(10)	33	(1,000)	11	(1,000)	(1,000)	(10)	201	648	603	9	3	33%
p-cymene	3,464	(1,000)	(10)	(10)	(1,000)	84	2,320	(1,000)	(10)	652	989	1,956	9	3	33%
diphenylamine	(1,000)	(1,000)	(10)	(10)	(1,000)	36	(1,000)	(1,000)	(10)	4	563	36	9	1	11%
n-decane	(1,000)	3,481	(10)	34,154	(1,000)	(10)	9,117	(1,000)	394	5,238	5,574	11,787	9	4	44%
n-docosane	6,391	(1,000)	(10)	(10)	(10)	(10)	(1,000)	(1,000)	(10)	710	1,049	6,391	9	1	11%
n-dodecane	3,362	2,141	(10)	8,218	(1,000)	(10)	(1,000)	(1,000)	180	1,545	1,880	3,475	9	4	44%
n-eicosane	(1,000)	(1,000)	(10)	2,515	(1,000)	(10)	(1,000)	(1,000)	159	297	855	1,337	9	2	22%
n-hexadecane	(1,000)	(1,000)	94	846	(1,000)	(10)	(1,000)	4,994	162	677	1,123	1,524	9	4	44%
2-methylnaphthalene	(1,000)	(1,000)	186	112	(1,000)	(10)	(1,000)	(1,000)	b	37	664	149	8	2	25%
n-octadecane	(1,000)	(1,000)	(10)	(10)	(1,000)	(10)	226	6,319	115	740	1,077	2,220	9	3	33%
styrene	(1,000)	(1,000)	(10)	102	(1,000)	(10)	(1,000)	(1,000)	(10)	11	570	102	9	1	11%
n-tetracosane	8,351	1,379	(10)	(10)	(1,000)	(10)	(1,000)	(1,000)	(10)	1,081	1,419	4,865	9	2	22%
n-tetradecane	18,615	11,212	(10)	655	(1,000)	(10)	(1,000)	21	85	3,399	3,623	6,118	9	5	56%
										....	....	....			
Subtotal										15,195	21,082	43,272			
Estimated Mass Discharge (lb/yr)										2,241,863	3,110,487	6,384,287			

TABLE 6-6

INDUSTRIAL LAUNDRIES INDUSTRY MASS LOADING ESTIMATE

COMPOUND	RAW WASTEWATER DATA									METHOD A	METHOD B	METHOD C			
	LAUNDRY A1	LAUNDRY A2	LAUNDRY B1	LAUNDRY B2	LAUNDRY C1	LAUNDRY C2	LAUNDRY D1	LAUNDRY D2	LAUNDRY E	AVERAGE	AVERAGE	AVERAGE	NUMBER OF SAMPLES ANALYZED	NUMBER OF DETECTS	PERCENT OF OCCURANCE
Pesticides and Herbicides (ug/l)															
azinphos ethyl	278	(500)	(100)	(100)	(100)	(100)	(100)		b	40	183	278	7	1	14%
dioxathion	565	(1,000)	(200)	(200)	(200)	(200)	(200)		b	81	366	565	7	1	14%
EPN	(250)	(250)	(50)	(50)	(50)	(50)	1,582		(0.002)	198	285	1,582	8	1	13%
atridazone	15	(2,500)	(50)	(50)	(50)	(50)	(250)			2	424	15	7	1	14%
phosmet	(500)	28	(100)	(100)	(100)	(100)	(100)		b	4	147	28	7	1	14%
tetrachlorovinphos	(250)	(250)	(50)	(50)	(50)	(50)	692		(0.004)	87	174	692	8	1	13%
Subtotal										411	1,579	3,160			
Estimated Mass Discharge (lb/yr)										60,612	232,918	466,225			
Common Ions (ug/l)															
calcium	11,000	14,000	168,000	42,800	23,400	21,500	51,577	45,728	b	47,251	47,251	47,251	8	8	100%
iron	3,100	8,500	63,400	20,200	19,700	28,900	78,018	35,972	13,000	30,088	30,088	30,088	9	9	100%
magnesium	2,400	4,000	35,000	11,100	7,250	5,540	14,716	12,513	b	11,565	11,565	11,565	8	8	100%
sodium	710,000	710,000	249,000	349,000	1,310,000	727,000	331,763	312,252	b	587,377	587,377	587,377	8	8	100%
Subtotal										676,280	676,280	676,280			
Estimated Mass Discharge (lb/yr)										99,778,103	99,778,103	99,778,103			
Metals and Elements (ug/l)															
aluminum	1,900	4,200	10,400	5,440	6,730	10,600	6,164	9,808	b	6,905	6,905	6,905	8	8	100%
barium	460	1,400	1,560	1,390	762	738	1,857	1,423	429	1,113	1,113	1,113	9	9	100%
boron	540	430	568	523	242	551	894	805	b	569	569	569	8	8	100%
cobalt	80	200	345	324	(50)	(50)	280	127	(50)	151	167	226	9	6	67%
manganese	100	250	1,090	372	343	373	1,186	654	b	546	546	546	8	8	100%
molybdenum	320	300	202	189	(100)	102	499	177	b	224	236	256	8	7	88%
tin	(130)	79	234	179	47	234	349	296	b	177	194	203	8	7	88%
titanium	48	150	213	118	227	270	337	300	b	205	205	205	8	8	100%
vanadium	7	10	44	15	(50)	(50)	32	57	(50)	18	35	28	9	6	67%
Subtotal										9,909	9,971	10,051			
Estimated Mass Discharge (lb/yr)										1,461,947	1,471,107	1,482,864			

TABLE 6-6

INDUSTRIAL LAUNDRIES INDUSTRY MASS LOADING ESTIMATE

COMPOUND	RAW WASTEWATER DATA									METHOD A	METHOD B	METHOD C	NUMBER OF SAMPLES ANALYZED	NUMBER OF DETECTS	PERCENT OF OCCURANCE
	LAUNDRY A1	LAUNDRY A2	LAUNDRY B1	LAUNDRY B2	LAUNDRY C1	LAUNDRY C2	LAUNDRY D1	LAUNDRY L2	LAUNDRY E	AVERAGE	AVERAGE	AVERAGE			
Conventional Pollutants (mg/l)															
BOD	1,980	1,800	680	1,500	800	900	1,015	1,265	222	1,120	1,120	1,120	9	9	100%
O&G, total recoverable	1,200 a	840 a	410 a	650 a	920 a	140 a	1,459 a	2,388 a	b	1,001	1,001	1,001	8	8	100%
TSS	930	1,000	1,100	740	760	930	1,894	1,551	464	1,041	1,041	1,041	9	9	100%
Subtotal										3,162	3,162	3,162			
Estimated Mass Discharge (lb/yr)										466,534,559	466,534,559	466,534,559			
Miscellaneous (mg/l)															
COD	5,800	4,900	3,300	4,800	4,800	6,100	5,002	5,717	1,520	4,660	4,660	4,660	9	9	100%
Subtotal										4,660	4,660	4,660			
Estimated Mass Discharge (lb/yr)										687,518,143	687,518,143	687,518,143			

(XX) = Indicates pollutant concentration is less than the detection limit; XX is the detection limit.
Method A = Using all data, including the absolute values of the results in parentheses. Average is sum of detected concentrations and detection limits of undetected pollutants divided by number of samples analyzed.
Method B = Using only the results which were above the detection limit. Average is sum of detected concentrations divided by number of detections.
Method C = Using only the results which were above the detection limit. Average is sum of detected concentrations divided by number of samples analyzed.
a = Composite of results from grab samples.
b = Not analyzed.

TABLE 6-7
ESTIMATED ANNUAL RAW WASTE LOADINGS FOR ITD-LISTED ANALYTES FOR THE INDUSTRIAL LAUNDRIES INDUSTRY ITD/RCRA SAMPLING PROGRAM

Pollutant Group	Estimated Annual Loading (1,000 lb/yr)		
	Method A[1,2]	Method B[1,3]	Method C[1,4]
Volatile Organic Compounds[5]			
Priority Pollutants	1,520	1,537	2,192
Hazardous Nonconventional Pollutants	23,446	23,546	24,452
Total	24,966	25,083	26,644
Semivolatile Organic Compounds[5]			
Priority Pollutants	973	2,016	3,566
Hazardous Nonconventional Pollutants	2,242	3,110	6,384
Total	3,215	5,126	9,950
Pesticides and Herbicides[5]			
Priority Pollutants	28	29	113
Hazardous Nonconventional Pollutants	61	233	466
Total	89	262	579
Metals and Elements[5]			
Priority Pollutants	1,553	1,556	1,589
Hazardous Nonconventional Pollutants	1,462	1,471	1,483
Total	3,015	3,027	3,072
Miscellaneous Priority Pollutants			
Cyanide	298	298	298
Miscellaneous Nonconventional Pollutants			
Common Ions (Ca, Fe, Mg, Na)	99,778	99,778	99,778
COD	687,518	687,518	687,518
Conventional Pollutants			
BOD5	165,245	165,245	165,245
Oil and grease	147,688	147,688	147,688
TSS	153,589	153,589	152,589

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[1] Based on 1000 facilities operating 260 days per year and discharging 68,000 gallons per day per facility.

[2] Mass load estimates are based on individual pollutant average concentrations that were developed assuming "not detected" observations were equal to zero.

[3] Mass load estimates are based on individual pollutant average concentrations that were developed assuming "not detected" observations were equal to the analytical detection limit.

[4] Mass loading estimates are based on individual pollutant average concentrations that only included observations reported above analytical detection limits.

[5] See Table 6-6 for list of specific compounds.

TABLE 6-8
INDUSTRIAL LAUNDRIES INDUSTRY MASS LOADING ESTIMATE

COMPOUND	RAW WASTEWATER DATA											METHOD A	METHOD C	NUMBER OF SAMPLES ANALYZED	NUMBER OF DETECTS	PERCENT OF OCCURANCE
PRIORITY POLLUTANTS	PLANT 1	PLANT 2	PLANT 3	PLANT 4	PLANT 5	PLANT 6	PLANT 7	PLANT 7	PLANT 8	PLANT 8	PLANT 9	AVERAGE	AVERAGE			
Volatile Organics (ug/l) (a)																
benzene	3	(999)	(999)	130	b	b	(999)	b	(999)	b	b	22	67	6	2	33%
bromodichloromethane	(999)	(999)	(999)	(999)	b	b	6	b	(999)	b	b	1	6	6	1	17%
carbon tetrachloride	2	(999)	(999)	(999)	b	b	1,700	b	(999)	b	b	284	851	6	2	33%
chloroform	1	10	35	(999)	b	b	6	b	(999)	b	b	9	13	6	4	67%
ethylbenzene	25	260	1,000	17,500	b	b	3	b	(999)	b	b	3,131	3,758	6	5	83%
methylene chloride	2	540	110	(999)	b	b	(999)	b	(999)	b	b	109	217	6	3	50%
tetrachloroethene	320	880	84	30	b	b	1	b	(999)	b	b	219	263	6	5	83%
toluene	360	750	2,400	2,600	b	b	5	b	(999)	b	b	1,019	1,223	6	5	83%
1,1,1-trichloroethane	18	(999)	(999)	(999)	b	b	3,303	b	(999)	b	b	554	1,661	6	2	33%
trichloroethene	4	210	(999)	(999)	b	b	(999)	b	(999)	b	b	36	107	6	2	33%
Subtotal												5,383	8,165			
Estimated Mass Discharge (lb/yr)												793,722	1,203,918			
Semivolatile Organics (ug/l)																
bis(2-ethylhexyl)phthalate	1,200	(999)	(999)	2,600	b	b	120	b	5,100	b	b	1,503	2,255	6	4	67%
butyl benzyl phthalate	310	(999)	(999)	(999)	b	b	(999)	b	1,500	b	b	302	905	6	2	33%
2-chloronaphthalene	(999)	(999)	(999)	(999)	b	b	17	b	(999)	b	b	3	17	6	1	17%
dichlorobenzenes	1,100	(999)	(999)	(999)	b	b	(999)	b	(999)	b	b	183	1,100	6	1	17%
di-n-butyl phthalate	92	(999)	(999)	(999)	b	b	300	b	660	b	b	175	351	6	3	50%
di-n-octyl phthalate	150	(999)	(999)	(999)	b	b	(999)	b	410	b	b	93	280	6	2	33%
2,4-dimethylphenol	460	(999)	(999)	(999)	b	b	(999)	b	(999)	b	b	77	460	6	1	17%
isophorone	(999)	190	(999)	(999)	b	b	(999)	b	(999)	b	b	32	190	6	1	17%
naphthalene	4,800	4,000	(999)	(999)	b	b	23	b	410	b	b	1,539	2,308	6	4	67%
N-nitrosodiphenylamine	(999)	1,800	(999)	(999)	b	b	(999)	b	(999)	b	b	300	1,800	6	1	17%
phenanthrene	380	(999)	(999)	(999)	b	b	8	b	(999)	b	b	65	194	6	2	33%
phenol	98	600	100	(999)	b	b	20	46	8	b	b	125	165	7	6	86%
Subtotal												4,396	10,005			
Estimated Mass Discharge (lb/yr)												648,231	1,475,286			
Metals (ug/l)																
antimony	96	41	(25)	160	120	(999)	2,400	600	170	(999)	88	398	512	9	7	78%
arsenic	10	12	13	(999)	11	(999)	9	(50)	25	(999)	(999)	9	13	9	6	67%
cadmium	110	17	56	70	60	60	40	20	60	120	(999)	55	55	9	9	100%
chromium	480	270	1,200	980	300	647	445	38	600	390	230	551	551	9	9	100%
copper	1,500	1,600	1,200	1,700	1,000	(999)	810	360	4,000	(999)	1,570	1,354	1,521	9	8	89%
lead	4,800	9,400	4,400	5,400	3,000	5,440	1,050	100	9,000	13	7,960	4,732	4,732	9	9	100%
mercury	(999)	2	1	(999)	(3)	0	2	1	2	(0.2)	(999)	1	2	8	5	63%
nickel	350	150	50	80	80	(20)	455	50	100	(20)	140	166	166	9	8	89%
silver	(999)	(999)	(29)	(999)	8	(999)	117	(999)	(2)	(999)	(999)	14	63	9	2	22%
zinc	3,700	4,500	2,600	2,700	2,000	2,880	2,550	1,000	4,000	2,370	3,280	2,881	2,881	9	9	100%
Subtotal												10,141	10,696			
Estimated Mass Discharge (lb/yr)												1,495,385	1,547,751			

TABLE 6-8
INDUSTRIAL LAUNDRIES INDUSTRY MASS LOADING ESTIMATE

COMPOUND	RAW WASTEWATER DATA											METHOD A	METHOD C	NUMBER OF SAMPLES ANALYZED	NUMBER OF DETECTS	PERCENT OF OCCURANCE
	PLANT 1	PLANT 2	PLANT 3	PLANT 4	PLANT 5	PLANT 6	PLANT 7	PLANT 7	PLANT 8	PLANT 8	PLANT 9	AVERAGE	AVERAGE			
Priority Pollutant Misc. (ug/l)																
cyanide	57	(999)	(999)	280	240	(999)	26	(10)	(20)	(999)	(999)	67	151	9	4	44%
Subtotal												67	151			
Estimated Mass Discharge (lb/yr)												9,879	22,228			
NONCONVENTIONAL POLLUTANTS (mg/l)																
COD	6,400	3,800	3,200	7,100	4,900	b	2,550	1,290	3,600	b	(999)	4,105	4,105	8	8	100%
Subtotal												4,105	4,105			
Estimated Mass Discharge (lb/yr)												605,287,176	605,287,176			
CONVENTIONAL POLLUTANTS (mg/l)																
BOD	b	b	b	2,400	1,700	877	346	180	1,400	119	1,253	1,151	1,151	6	6	100%
O&G, total recoverable	831	440	760	1,600	230	513	205	175	630	1,090	860	598	598	9	9	100%
TSS	390	700	520	940	900	792	499	5,151	520	895	1,057	590	590	9	9	100%
Subtotal												2,339	2,339			
Estimated Mass Discharge (lb/yr)												344,880,165	344,880,165			

(XX) = Indicates pollutant concentration is less than the detection limit; XX is the detection limit.
(999) = Indicates pollutant was not detected. Detection limit is unknown.
Method A = Using only the results which were above the detection limit. Average is sum of detected concentrations divided by number of samples analyzed.
Method C = Using only the results which were above the detection limit. Average is sum of detected concentrations divided by number of detections.
a = Composite of results from grab samples.
b = Not analyzed.

TABLE 6-9
ESTIMATED ANNUAL RAW WASTE LOADINGS FOR PRIORITY POLLUTANTS AND SELECTED CONVENTIONAL AND NONCONVENTIONAL POLLUTANTS FOR THE INDUSTRIAL LAUNDRIES INDUSTRY 1978 SCREENING PROGRAM

Pollutant Group	Estimated Annual Loading (1,000 lb/yr)		
	Method A[1,2]	Method B[1,3]	Method C[1,4]
Volatile Organic Compounds[5]			
Priority Pollutants	794		1,204
Semivolatile Organic Compounds[5]			
Priority Pollutants	648		1,475
Pesticides and Herbicides			
Priority Pollutants	0		0
Metals and Elements[5]			
Priority Pollutants	1,495		1,548
Miscellaneous Priority Pollutants			
Cyanide	10		22
Miscellaneous Nonconventional Pollutants			
COD	605,287		605,287
Conventional Pollutants			
BOD5	169,716		169,716
Oil and grease	88,176		88,176
TSS	86,996		86,996

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[1] Based on 1000 facilities operating 260 days per year and discharging 68,000 gallons per day per facility.

[2] Mass load estimates are based on individual pollutant average concentrations that were developed assuming "not detected" observations were equal to zero.

[3] Mass load estimates are based on individual pollutant average concentrations that were developing assuming "not detected" observations were equal to the analytical detection limit. Detection limits were not available and this method was not used.

[4] Mass loading estimates are based on individual pollutant average concentrations that only included observations reported above analytical detection limits.

[5] See Table 6-8 for list of specific compounds.

6.4.3 Comparison of Annual Average Raw Waste Mass Loadings - Table 6-10 presents a comparison of the average raw waste concentration of each pollutant group using data from the current ITD/RCRA Sampling Program and data from the 1978 Screening Sampling Program. Table 6-11 presents a comparison of the annual average mass loadings developed for each pollutant group based on the two sampling programs. The estimates of the industry average concentrations and mass loadings presented in Tables 6-10 and 6-11 are based on the determination of average pollutant concentrations by Method A and are therefore conservative. No comparisons were possible for the hazardous nonconventional volatile or semivolatile organics or any nonconventional metals as no samples were analyzed for these pollutants during the 1978 screening sampling program.

The mass loadings developed from the ITD/RCRA data and the 1978 data for BOD_5, COD, and priority pollutant metals agree very closely. The loadings for TSS, oil and grease, and priority pollutant volatile and semivolatile organics developed from 1978 data are 40 to 50 percent less than the loadings developed from the ITD/RCRA data. The difference may reflect the highly variable nature of industrial laundry wastewaters.

6.4.4 Annual Final Effluent Pollutant Mass Loadings - No attempt has been made during this study to estimate the annual mass pollutant loadings discharged by the industrial laundries industry to the nation's POTWs. Settling basins, dissolved air flotation clarifiers, and membrane filtration systems are the types of pretreatment systems known to be used by the industry. Data are available to estimate the pollutant removals of each type of pretreatment. The first is relatively ineffective and the second and third types achieve relatively high pollutant removals. However, we have no data on the number of laundries that use each type of pretreatment system. It is therefore not possible to make any reasonable estimate of the pollutant reduction achieved by the industry as a whole before discharge to the sewer.

TABLE 6-10
COMPARISON OF ESTIMATED INDUSTRY AVERAGE CONCENTRATIONS OF INDIVIDUAL POLLUTANTS IN INDUSTRIAL LAUNDRIES RAW WASTEWATERS ITD/RCRA SAMPLING PROGRAM vs. 1978 SCREENING PROGRAM

Pollutant Category and Pollutant	ITD/RCRA[1] Average[3] Concentration (μg/ℓ)	Screening[2] Average[3] Concentration (μg/ℓ)
Priority Pollutant Metals		
antimony	75	384
arsenic	16	13
beryllium	1	--
cadmium	131	59
chromium	453	564
copper	2,021	1,670
lead	3,108	5,120
mercury	1	1.3
nickel	276	176
selenium	28	--
silver	17	31
zinc	4,400	3,160
Priority Pollutant Volatile Organic Compounds		
benzene	--	22
carbon tetrachloride	--	142
1,1,1-trichloroethane	1,302	553
chloroform	1	8
ethylbenzene	2,825	3,131
methylene chloride	1,450	109
dichlorobromomethane	--	1
tetrachloroethene	2,039	219
toluene	2,591	1,019
trichloroethene	26	36
chlorobenzene	5	--
2-chloroethylvinyl ether	3	--
1,1-dichloroethane	3	--
1,1-dichloroethene	35	--
trans-1,2-dichloroethene	24	--
Priority Pollutant Semi-volatile Organic Compounds		
2-chloronaphthalene	512	3
dichlorobenzenes	--	183
2,4-dimethylphenol	--	77
isophorone	998	32
naphthalene	1,659	1,539
N-nitrosodiphenylamine	4	300
phenol	--	136
bis(2-ethylhexyl) phthalate	527	1,170
butyl benzyl phthalate	--	301
di-n-butyl phthalate	--	175
di-n-octyl phthalate	2	93
anthracene/phenanthrene	2	143
benzidine	713	--
nitrobenzene	4	--
N-nitrosodi-n-propylamine	2,174	--
Cyanide		
cyanide, total	2,020	121

TABLE 6-10 (continued)

Pollutant Category and Pollutant	ITD/RCRA[1] Average[3] Concentration (μg/ℓ)	Screening[2] Average[3] Concentration (μg/ℓ)
Pesticides and Herbicides		
aldrin	1	--
BHC; alpha	1	--
endosulfan sulfate	181	--
heptachlor	3	--
Conventional Pollutants		
BOD5	1,120,000	1,420,000
oil and grease	1,001,000	695,000
TSS	1,041,000	691,000
Nonconventional Pollutants		
COD	4,660,000	3,684,000

--Not detected in any sample.

[1] Data are from 1986-7 ITD/RCRA Sampling Program.

[2] Data are from 1978 Screening Program. See 1982 Guidance Document, Section 5 and Appendix A (6). Data presented here are average influent concentrations at Plants A, B, C, D, E, K, L, and Z.

[3] Estimated averages are based on the assumption that "not detected" observations are equal to zero (see Method A in text).

TABLE 6-11
COMPARISON OF ESTIMATED ANNUAL RAW WASTE LOADINGS FOR PRIORITY POLLUTANTS AND SELECTED CONVENTIONAL AND NONCONVENTIONAL POLLUTANTS FOR THE INDUSTRIAL LAUNDRIES INDUSTRY
ITD/RCRA SAMPLING PROGRAM vs. 1978 SCREENING PROGRAM

Pollutant Group	Estimated Annual Loading (1,000 lb/yr)[1,2]	
	ITD/RCRA	1978 Screening
Volatile Organic Compounds[3]		
Priority Pollutants	1,520	794
Semivolatile Organic Compounds[3]		
Priority Pollutants	973	648
Pesticides and Herbicides[3]		
Priority Pollutants	28	0
Metals and Elements[3]		
Priority Pollutants	1,553	1,495
Miscellaneous Priority Pollutants		
Cyanide	298	10
Miscellaneous Nonconventional Pollutants		
COD	678,518	605,287
Conventional Pollutants		
BOD5	165,245	169,716
Oil and grease	147,688	88,176
TSS	153,589	86,996

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[1] Based on 1000 facilities operating 260 days per year and discharging 68,000 gallons per day per facility.

[2] Mass load estimates are based on individual pollutant average concentrations that were developed assuming "not detected" observations were equal to zero (see Text-Method A).

[3] See Table 6-10 for list of specific compounds.

SECTION 7

7.0 CONTROL AND TREATMENT TECHNOLOGY

The following descriptions and evaluations of technologies for the control and treatment of laundry wastewaters are based on their applicability in removing various pollutants prior to the discharge of the wastewater to a POTW. The pollutants found most consistently or at highest concentrations, as presented in Section 5, are the basis for evaluation of currently applicable technology. In addition, handling and disposal of sludges generated by these technologies are discussed.

All known industrial laundries discharge to POTWs. Therefore, removal of pollutants incompatible with POTW operation is a major concern of the laundry industry. The extent and type of control practiced by individual laundries has been dependent on local sewer ordinances, geographic location, and economic considerations.

Conventional in-plant controls and physical-chemical treatment systems presently used for pretreatment of laundry wastewater prior to discharge to a POTW are discussed in this section. Potentially applicable treatment technology not known to be in use in the industry at present is discussed in earlier EPA documents (6).

Some conventional controls remove gross pollutants such as lint and sand which may obstruct piping and sewer drains and disrupt laundry operations. Another conventional control, heat reclamation, may be used to reduce the temperature of the effluent wastewater and preheat incoming fresh water. Physical-chemical treatment systems (PCSs) are designed to meet municipal sewer ordinances established for the control of pollutants which may include oil and grease, organics, heavy metals, and pH.

Sludges resulting from the treatment of laundry wastewater must be handled and disposed of. Ultimate disposal of laundry sludge can be accomplished by landfilling or incineration.

In 1977, an EPA technical survey showed that approximately 70 percent of the industrial laundry facilities had lint screens, 70 percent had catch basins, and 72 percent had heat reclaimers. One to two percent had physical-chemical systems (dissolved air flotation), 15 percent had oil skimmers, and 8 percent had filtration, separators, oil hold-back devices, or other miscellaneous operations. Trade association personnel and laundry personnel have stated that more laundries have installed pretreatment systems since the Agency's previous data gathering efforts. Physical-chemical systems have been installed, including both dissolved air flotation and ultra-filtration systems. However, no plant-specific information is currently available.

7.1 CONVENTIONAL TECHNOLOGY

Generally, conventional technology is designed to remove gross pollutants such as solids (lint, sand, grit) and free oil. Heat reclaimers are used to recover heat from the wastewater prior to discharge and to preheat incoming fresh water.

7.1.1 Solids Removal

Bar screens, lint screens, and catch basins (settling pits) are used to remove sand, grit, lint, and other noncolloidal solids from laundry wastewater. Solids removal is accomplished in many laundries to prevent the obstruction of piping and drains.

Bar screens are flat steel bars welded together in a grid pattern forming spaces typically 0.25 in. by 0.75 in. They are designed to allow the free flow of effluent while removing large objects from the wastewater stream, and are usually cleaned by hand.

Lint screens are usually installed after bar screens to remove lint and other particles such as sand and grit. They are generally cylindrical or rectangular, and are constructed of wire mesh or perforated metal plate, with openings typically 0.37 in. by 0.12 in. They are cleaned manually or mechanically. Mechanical cleaning is usually accomplished by a rotating or vibrating lint screen which causes the trapped lint to fall off the screen into a collection container.

Catch basins may also be used in combination with lint screens to remove sand and grit from laundry wastewaters by gravity settling. They are typically built below ground and have hydraulic detention times of between 15 and 40 minutes. The effectiveness of solids settling depends on the characteristics of the particular laundry wastewater, basin geometry, and the hydraulic detention time of the catch basin.

Flow equalization of laundry effluent is generally required to optimize the performance of additional physical-chemical treatment technologies such as dissolved air flotation. Holding tanks with detention times of 2 to 4 hours are considered adequate. Detention times of this magnitude will also usually provide the maximum removal of suspended solids achievable without resorting to additional technology. Holding tanks also provide thermal equalization and some reduction in variability of pollutant concentrations, both of which facilitate operation of additional treatment systems. Physical, chemical, and biological reactions can occur in an equalization tank, and may cause reductions in pollutant concentrations (9).

7.1.2 Free Oil Removal

Oil and grease, by definition, comprises compounds that can be separated from water by freon, hexane, or ether extraction. Data collected from industrial laundries indicate that 5% to 10% of the total oil and grease loading is free or non-emulsified oil. The remainder exists as a water-oil emulsion.

Free oil removal treatment techniques (10) consist of retaining the oily water in a holding tank and allowing gravity separation of the oily material from water. The oils rise to the surface and are mechanically skimmed from the water.

7.1.3 Temperature Control

Heat reclaimers are used in the laundry industry to preheat incoming fresh water prior to use in the wash process. Preheating is accomplished by noncontact heat transfer from laundry wastewater. Laundry effluent temperatures can be reduced from 140°F-160°F to 80°F-100°F with corresponding savings of fuel.

7.1.4 Capabilities of Conventional Technology

Data presented in earlier documents, and summarized in Table 7-1, indicate that the effectiveness of conventional treatment in removing pollutants is extremely variable, and the results of earlier studies were inconclusive. Median removal rates for several conventional and toxic pollutants ranged from zero to 32 percent. Data characterizing pollutant removals by conventional treatment were obtained at two facilities during the current EPA sampling program. These data are presented in Table 7-2. They show the same extreme variability as the earlier data and are equally inconclusive.

7.2 INCOMPATIBLE POLLUTANT REMOVAL - PRESENTLY APPLIED TECHNOLOGIES

Incompatible pollutants are pollutants that interfere with POTW operation or pass through a POTW and prevent it from meeting its limitations. To avoid these problems, POTWs must regulate the discharge of incompatible pollutants at the source.

Laundries operating under regulations that limit the discharge of incompatible pollutants have, in the past, used dissolved air flotation systems (DAF) for wastewater treatment. In recent years, ultrafiltration (U/F) systems have been installed in a number of laundries and appear to be operating satisfactorily. Both DAF and U/F systems are described in the following sections.

7.2.1 Dissolved Air Flotation (DAF) Treatment Technology

DAF treatment of laundry wastewater comprises the following unit operations: flow equalization, chemical addition, flocculation, flotation, and sludge disposal. Figure 7-1 is a block diagram for laundry wastewater pretreatment using DAF technology. Conventional controls, such as lint screens and catch basins, are assumed to be in place.

Flow Equalization - Constant flow and reduced variation of pollutant concentrations will allow more efficient operation of a particular treatment system. As laundry wastewater flows and pollutant concentrations can vary by orders of magnitude during a

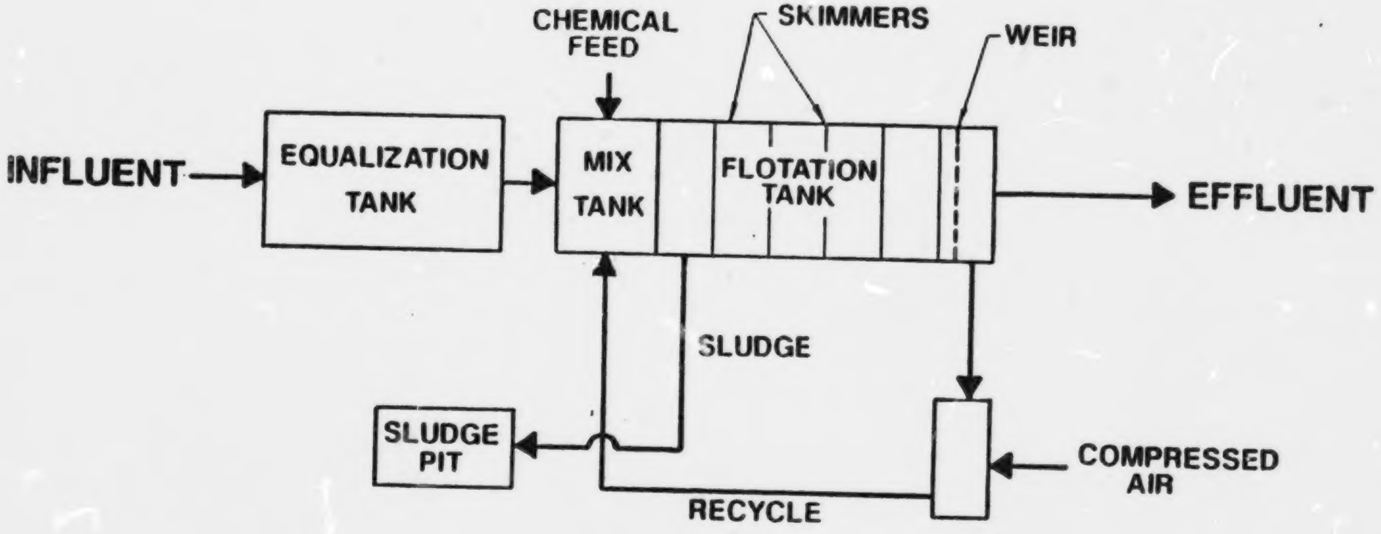
CHEMICAL FEED
SKIMMERS
WEIR
INFLUENT
EQUALIZATION TANK
MIX TANK
FLOTATION TANK
EFFLUENT
SLUDGE
SLUDGE PIT
COMPRESSED AIR
RECYCLE

FIGURE 7-1
DISSOLVED AIR FLOATATION
TREATMENT SYSTEM
FOR LAUNDRY WASTEWATER

TABLE 7-1
SUMMARY OF REMOVAL EFFICIENCIES OF SELECTED POLLUTANTS BY CONVENTIONAL TREATMENT[1] AT THREE INDUSTRIAL LAUNDRIES[2]

Pollutant Parameter	Median Percent Removal	Range of Percent Removals	Median Influent Concentration (mg/ℓ)	Range of Influent Concentrations (mg/ℓ)	Number of Samples
oil and grease	19	0 - 65	620	190 - 1,350	9
BOD_5	6	0 - 18	310	170 - 660	9
TSS	0	0 - 20	500	210 - 1,300	9
copper	28	0 - 66	0.12	0.03 - 0.69	8
lead	32	0 - 91	0.52	0.22 - 2.4	9
zinc	0	0 - 99	0.45	0.38 - 0.86	5

[1] Includes bar screen, lint screen, catch basin and heat reclaimer.

[2] Data are from 1978 Screening Program. See 1982 guidance document (6).

TABLE 7-2

SUMMARY OF REMOVAL EFFICIENCIES OF SELECTED POLLUTANTS BY CONVENTIONAL TREATMENT[1] AT TWO INDUSTRIAL LAUNDRIES ITD/RCRA SAMPLING PROGRAM[2]

Pollutant Parameter	Median Percent Removal	Range of Percent Removals	Median Influent Concentration (mg/ℓ)	Range of Influent Concentrations (mg/ℓ)	Number of Samples
oil and grease	0	0 - 49	250	140 - 920	4
BOD_5	15	0 - 68	705	540 - 900	4
TSS	39	0 - 56	765	490 - 930	4
copper	37	8 - 65	1.55	1.29 - 2.06	4
Lead	10	0 - 46	2.04	0.97 - 3.50	4
zinc	31	23 - 42	4.82	3.92 - 5.45	4
calcium	25	20 - 63	34.5	21.5 - 47.4	4
iron	49	28 - 71	26.7	19.7 - 63.6	4
acetone	0	0 - 94	0.92	0.06 - 17.5	4
tetrachlorethene	23	0 - 53	0.31	0.09 - 0.84	3
toluene	86	0 - 100	0.23	0.136 - 6.64	3

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[1] Bar screen, 2 catch basins, and heat reclaimer at facility C; lint screen, heat reclaimer, and 2 catch basins at facility D (uniform washers only). See Section 5.

[2] Data are from 1986 EPA Sampling Program. See Section 5.

day's operation, equalization of flow and pollutant loads prior to DAF treatment is necessary to obtain optimal operation of a DAF system (25). This usually can be accomplished with equalization basins of one-half days hydraulic detention time. Equalization tanks at laundries may require cleaning on a regular basis to remove settled solids and grease deposits, or they may be agitated to prevent settling.

Chemical Addition - Pollutants, such as oil and heavy metals, are usually found in laundry wastewater in the form of colloidal suspensions which cannot be effectively treated solely by physical techniques. Chemical addition is used to aggregate the colloidal material into particles that can be physically removed by flotation, sedimentation, or filtration.

Emulsified oil and grease is aggregated by chemical addition using coagulation, acidification, or both in conjunction with flocculation mechanisms. Coagulation is accomplished with chemical additives that destabilize the colloidal material, either by reducing the electrostatic repulsive forces between colloids or by forming positively charged hydrous oxides which are absorbed on the surface of the colloid (10, 11). Other pollutants which exist as colloids in laundry wastewater, such as lead, copper, and zinc, are also destabilized by coagulation. Acidification of oil and grease colloids is accomplished by lowering the pH to a point where dispersed oil droplets aggregate and the emulsion is said to be broken (10). Coagulation and acidification may both be used in a DAF system to treat laundry wastewater.

The chemicals are added at prescribed rates to the raw wastewater to destabilize colloidal suspensions in laundry wastewater. The following coagulants are currently in use.

Aluminum sulfate (Alum, $Al_2(SO_4)_3$)
Calcium chloride ($CaCl_2$)
Ferric sulfate ($Fe_2(SO_4)_3$)
Ferrous sulfate ($Fe(SO_4)$)
Cationic polyelectrolytes

The choice is based on efficiency of particle formation and ease of hauling and disposing of the solids generated.

Flocculation - Flocculation is defined as particle transport, contact, and formation occurring as a result of colloidal destabilization (coagulation). Particle transport results from thermal motion, bulk fluid motion (accomplished by mechanical stirring), and differential settling (12). Floc particles that form as a result of chemical coagulation contain the colloidal material intended for removal. In all cases flocs properly formed from interparticle contact can be removed by physical means. Since proper floc formation is dependent on various particle transport mechanisms (flocculation), the physical design of chemical addition equipment must provide adequate time and mixing for interparticle contacts during coagulation.

Design parameters necessary to achieve proper particle contact include hydraulic detention time in the mix tank and the physical methods used for mixing. The required detention time for flocculation is generally inversely proportional to solids concentration (12). Mixing must provide adequate particle contact, and it is achieved by baffles in mix tanks and turbulence caused by pumping and air injection into the stream.

Flotation - In the pretreatment of laundry effluents, floc is brought to the surface of a thickener unit by means of dissolved air flotation. DAF is accomplished by pressurizing all or part of the effluent stream with air to 40 to 80 psig. The increased pressure on the wastewater causes additional air to dissolve in the wastewater.

The pressure is then reduced back to atmospheric, forcing dissolved air out of solution in the form of minute bubbles throughout the entire volume of the liquid (13). These bubbles become attached to floc particles causing them to rise to the surface of a flotation tank (thickener) where the floc solids are skimmed off by rotating troughs or moving blades.

The principal components of a DAF unit are the pressurizing pump, retention tank, pressure-reducing valve, air injector, and a flotation tank. For laundry wastewater, two modes of pressurization are currently in use: full flow pressurization (FFP) and recycle pressurization (RP). In FFP the entire effluent stream is pressurized. In RP a stream of treated water is drawn from the flotation tank, ranging in volume from 50% to 120% of the effluent stream; this recycle stream is pressurized and mixed with the effluent as it enters the flotation tank.

Factors that affect the design of a DAF unit include feed solids concentration, hydraulic loading rate, and particle rise velocity (14). Air:solids ratios are frequently used to determine the design criteria for DAF systems. This ratio is defined as the weight of compressed air used during pressurization compared to the weight of solids entering the flotation tank (13). Typical air:solids ratios for DAF units are in the range of 0.005 to 0.1 (11, 13). Higher air:solids ratios can cause floc shearing due to increased turbulence, resulting in an overall loss of system efficiency.

The operating variables, air:solids ratio, hydraulic loading rate, and solids loading rate, have a direct effect on the performance of a DAF unit. For effective treatment, it is usually necessary to conduct pilot tests at the particular laundry before installation of a full-scale DAF unit. Large variations exist in contaminant loadings and hydraulic loadings between laundries.

Pretreatment technology using DAF is being practiced at a number of industrial laundries. Sampling data characterizing the treatment efficiencies in terms of percent removal by DAF clarifier were obtained at seven industrial laundries during an earlier Agency study. These data were presented in the 1982

Guidance Document. They are summarized and presented in this document in Table 7-3 (percent removals of selected conventional and nonconventional pollutants and priority pollutant metals) and Table 7-4 (percent removals of organic priority pollutants). During the present EPA sampling program additional sampling data were obtained at two facilities, both of which had previously been sampled. The most recent data characterizing DAF treatment efficiency for these facilities are presented in Table 7-5 (conventional and nonconventional pollutants, and miscellaneous priority pollutant metals) and Table 7-6 (priority and hazardous nonpriority organic pollutants). These data are the results of two separate days sampling at each facility.

The data obtained during earlier sampling events, shown in Table 7-3, indicate that DAF treatment can be effective in reducing metals, TSS, BOD5, COD, and oil and grease. The data obtained in the most recent sampling efforts (presented in Table 7-5) show removals for the same pollutants that range from lower to much lower than the average removals obtained during the earlier sampling program. The removal efficiencies for DAF treatment obtained during the current study are lower for each of the two facilities sampled than they were during the earlier study.[3] The most likely reason for lower removal efficiencies is that the POTWs to which these facilities discharge do not require the low pollutant levels previously attained.

DAF systems are not designed to remove hazardous organic compounds from the wastewater stream, but two mechanisms may accomplish an incidental removal of hazardous organics: through volatilization of many volatile organics, and through flotation of free or emulsified oil in which are dissolved some volatile and most semivolatile organics. In a single phase, aqueous solution, air bubbles formed as dissolved air comes out of solution would be expected to rapidly and effectively strip (volatilize) all but the most water soluble volatile organics from the solution. Laundry wastewater, however, is a two-phase system (oil and water) in which a large portion of the organics are selectively dissolved in the oil phase. Stripping of volatiles will occur but probably at a lower rate and possibly not to completion in the detention time of the DAF unit. The presence of large quantities of surfactants may also effect the volatilization of organic compounds.

Substantial fractions of volatile organics are not air-stripped and are dissolved in the oil phase of the laundry effluent with the semivolatile organics and both are removed by the floatation of the oil and grease. Data are not sufficient to determine principle removal pathways of specific compounds but the data do suggest that both volatilization and oil solubilization are significant removal mechanisms.

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[3] Compare data in Tables 5-6 and 5-7 with data for facilities D and E presented in Tables A-4 and A-5, respectively, of the 1982 Guidance Document (6).

Data presented in Table 7-4 shows highly variable removals of specific organic priority pollutants but significant removal of priority organics taken as a whole. Table 7-6 shows similar variability in removal of priority and hazardous nonconventional organics during the recent sampling, with good removals for many compounds. The removals of priority organics are roughly comparable to those found earlier, probably in part because removals of oil and grease are comparable. It is difficult to quantify effluent quality in terms of priority and hazardous nonconventional organics because of the variations in specific hazardous compounds found from plant to plant, the range of solubilities of those compounds in oil versus water, and the variations in oil and grease removals from plant to plant.

Sludge Disposal - The floc formed by coagulation and collected in the DAF unit results in a sludge composed of coagulant chemical precipitates and pollutants removed from the wastewater. Sludges from DAF units are typically liquid with a solids content of 5% to 8% by weight.

Dewatering techniques are used to convert sludge into a more solid form and reduce the overall volume of solid waste. Dewatering will usually make handling and disposal of sludges easier and less costly. Some laundries with DAF currently use rotary vacuum filters to dewatering sludge. These devices produce sludge cake with a solids content of between 20% and 30%.

A vacuum filter consists of a cylindrical rotating drum partially submerged in a vat of sludge. Sludge adheres to the drum surface which is made of cloth or steel mesh filter. Vacuum imparted to the inside of the rotating drum draws water from the sludge through the filter material to the drum interior where it collects and is either discharged as final effluent or directed back to treatment. The resulting dewatered sludge (filter cake) is scraped from the filter and collected. Some laundries with high solvent concentrations in their effluent have reported that the resulting sludges are difficult to dewater by rotary vacuum filtration, but no data are available and the reasons for the difficulty are not known.

Most laundries operating DAF systems employ outside contractors for sludge disposal. The contractors use either sanitary landfills or incinerators but previous site surveys have indicated that contractors predominantly use sanitary landfills. However, some laundry sludges have been found to be hazardous as defined by the Resource Conservation and Recovery Act (RCRA) and must be disposed of in RCRA approved landfills.

TABLE 7-3

SUMMARY OF REMOVAL EFFICIENCIES FOR COMMONLY MONITORED POLLUTANTS AT SEVEN INDUSTRIAL LAUNDRIES USING DISSOLVED AIR FLOTATION[1]

Pollutant	Average Percent Removal (%)	Range of Concentrations (mg/ℓ)	Range of Percent Removals (%)	Number of Facilities With Data
TSS	79.7	390-1,060	42.0-98.0	7
BOD_5	60.6	1,253-3,600	33.6-82.1	4
COD	67.0	1,300-7,100	50.0-77.6	6
oil and grease	72.3	230-1,600	47.2-95.6	7
antimony	50.9	0.025-0.170	0-89.4	5
cadmium	95.4	0.017-0.110	86.5-98.2	6
chromium	57.1	0.230-1.200	41.8-99.7	7
copper	75.2	1.00-4.00	40.1-97.5	7
lead	93.4	3.00-9.40	40.1-99.8	7
nickel	70.0	0.050-0.350	35.7-100	6
zinc	92.0	2.00-4.50	65.2-97.4	7

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[1] Data are from 1978 screening program. See 1982 Guidance Document (6), Section 7 and Appendix A.

TABLE 7-4

SUMMARY OF REMOVAL EFFICIENCIES BY DISSOLVED AIR FLOTATION FOR SELECTED[1] ORGANIC PRIORITY POLLUTANTS AT FOUR INDUSTRIAL LAUNDRIES[2]

Pollutant	Average Percent Removal	Range of Influent Concentration (mg/ℓ)	Range of Percent Removals	Number of times Detected
dichlorobenzenes	76	1.1	76	1
2,4-dimethylphenol	100	0.46	100	1
naphthalene	82	4.0-4.8	80-83	2
phenol	35	0.098-0.78	0-80	4
bis(2-ethylhexyl)phthalate	72	1.2-2.6	61-82	2
di-n-butyl phthalate	79	0.092-0.15	78-79	2
anthracene/phenanthrene	83	0.38	83	1
tetrachloroethene	31	0.084-0.88	0-94	3
toluene	20	0.36-2.6	0-65	4
ethylbenzene	54	0.26-17.5	3-100	3
methylene chloride	4	0.11-0.54	0-7	2
isophorone	100	0.19	100	1
N-nitrosodiphenylamine	68	1.8	68	1
trichloroethylene	86	0.21	86	1
benzene	0	0.13	0	1
cyanide	2	0.057-0.28	0-3	2

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[1] Pollutants shown here are those found at concentrations greater than 0.05 mg/ℓ in the DAF influent.

[2] Data are from 1978 screening program. See 1982 Guidance Document (6), Appendix A, Tables A-1, A-2, A-3, and A-4.

TABLE 7-5

SUMMARY OF REMOVAL EFFICIENCIES BY DISSOLVED AIR FLOTATION FOR SELECTED[1] CONVENTIONAL AND NONCONVENTIONAL POLLUTANTS AT TWO INDUSTRIAL LAUNDRIES ITD/RCRA SAMPLING PROGRAM[2]

Pollutant	Average Percent Removal	Range of Percent Removals	Range of Influent Concentrations (mg/ℓ)	Number of Samples
calcium	0	0	14-168	3
magnesium	57	33-79	4-35	3
sodium	5	0-10	249-710	3
aluminum	62	40-73	4.2-10.4	3
manganese	74	56-91	0.250-1.09	3
lead*	70	55-87	0.372-4.20	3
boron	16	0-40	0.430-0.568	3
barium	65	52-78	1.4-1.56	3
cadmium*	24	0-47	0.042-0.072	2
molybdenum	41	20-53	0.189-0.300	3
tin	77	62-100	0.079-0.234	3
cobalt	60	45-71	0.200-0.345	3
chromium*	34	27-41	0.251-0.835	3
copper*	59	43-71	1.570-2.610	3
iron	76	54-98	0.850-634	3
nickel*	57	42-72	0.099-0.320	3
titanium	49	48-66	0.118-0.213	3
zinc*	58	50-63	3.130-6.250	3
mercury*	59	55-62	0.00071-.0013	3
residue, filterable	10	0-24	1000-3400	4
residue, non-filterable	34	0-79	740-1100	4
cyanide, total*	17	0-43	0.17-0.30	4
fluoride	17	0-35	16-39	4
ammonia, as N	0	0	1.1-1.2	4
nitrogen, Kjeldahl, total	22	0-89	12-35	4
nitrate-nitrite, as N	38	0-70	0.21-1.5	4
total phosphorous, as P	34	0-47	15-36	4
BOD-5 Day (carbonaceous)	63	43-81	680-1900	4
chemical oxygen demand	50	43-58	3300-5800	4
oil and grease, total recoverable	71	66-79	410-1200	
total organic carbon	33	0-59	470-1100	4
sulfide, total (iodometric)	4	0-15	1.3-4.3	4

* Priority Pollutant

[1] Pollutants shown here are those found at concentrations greater than 0.05 mg/ℓ in the influent to the DAF clarifier.

[2] Data are from 1986 EPA Sampling Program (see Section 5).

TABLE 7-6

SUMMARY OF REMOVAL EFFICIENCIES BY DISSOLVED AIR FLOTATION FOR SELECTED[1] PRIORITY AND NONPRIORITY ORGANIC POLLUTANTS AT TWO INDUSTRIAL LAUNDRIES ITD/RCRA SAMPLING PROGRAM[2]

Pollutant	Average Percent Removal	Range of Percent Removal	Range of Influent Concentrations (mg/ℓ)	Found in Number of Samples
Volatile Organic Compounds				
tetrachloroethene*	100	100	58	1
toluene*	54	0-82	415-10,292	3
ethyl benzene*	93	79-100	103-12,396	4
acetone	73	0-100	493-15,831	4
Semi-volatile Organic Compounds				
alpha-terpineol	0	0	199	1
isophorone*	30	0-91	0-8,217	3
n-decane	77	53-100	3,481-34,154	2
biphenyl	100	100	1,766	1
n-docosane	50	0-100	0-6,391	2
n-dodecane	45	0-100	2,141-8,218	3
n-eicosane	96	96	2,515	1
n-octadecane	29	22-36	94-846	2
n-tetradecane	80	45-100	655-111,212	3
N-nitrosodi-n-propylamine*	72	15-100	850-14,945	3
naphthalene*	49	49	12,963	1
p-cymene	50	0-100	0-3,464	2
styrene	100	100	102	1
2-chloronaphthalene*	0	0	0-4,565	2
2-methylnapththalene	67	67	186	1
n-tetracosane	28	0-55	1,379-8,351	2
Pesticides/Herbicides				
azinphos ethyl	100	100	278	1
dioxathion	95	95	565	1

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[1] Pollutants shown here are those found at concentrations greater than 0.05 mg/ℓ in the influent to the DAF clarifier.

[2] Data are from 1986 EPA Sampling Program (see Section 5).

7.2.2 Membrane Filtration

Recent developments in membrane filtration technology have allowed the successful full scale application of the technology to industrial laundry wastewaters (15, 16). In 1982 no known full scale membrane filtration treatment system was operating in an industrial laundry. The key to the application of this technology to the laundries industry has been development of membranes which can withstand the chemical and physical environment of laundry wastewaters, and the use of a technique known as crossflow membrane filtration.

Membrane filtration is used to separate the components of a pressurized influent stream into two effluent streams by means of a semipermeable membrane (17,18,19). In crossflow filtration, the direction of the influent stream flow is parallel to the surface of the filtering membrane rather than perpendicular, as in the more familiar barrier type of filtration (20). The normal construction of the crossflow filter is tubular (see Figure 7-2) with the influent stream (the wastewater feed) flowing through the tube under pressure. A fraction of the feed stream consists of molecules, ions, and particles of low molecular weight which are small enough to pass through the pores of the membrane. A large portion of these, water, and water soluble solvents and solutes, do permeate the membrane forming a stream called the permeate. The remainder of the feed stream becomes the concentrate, containing high concentrations of larger molecules, suspended solids, and colloidal particles which can not permeate the membrane.

The greatest advantage to operating in a crossflow mode is that the flow of the feed-concentrate stream tends to prevent the build up of solids, and oils and greases, which would otherwise clog the filter and reduce the flow rate to below practical levels. The feed stream is operated at turbulent flow and prevents build-up of the concentrating solids on the membrane surface. The system is thus self-cleaning.

There are three classes of membranes used, leading to three types of filtration: reverse osmosis (R/O), ultrafiltration (U/F), and microfiltration (M/F). The principal difference in these membranes is the size of the pores, which limits the size of the materials which can pass through the membrane. R/O membranes have the smallest pores (0.0001 to 0.0015 microns) and can effect separation of solutes of molecular or atomic weights as low as 100. U/F membranes (pore size 0.0015 to 0.2 microns) allow permeation of solvents and solutes with maximum molecular weights of 500 to 300,000 depending on the pore size selected. M/F membranes (pore size greater than 0.1 micron) can be used to separate out solutes and particles with molecular weights greater than 100,000.

The physical-chemical mechanisms by which the three types of membrane filtration operate are different, and need not be discussed here. The results of the mechanisms are that R/O operates at highest pressure and lowest flux (rate of passage of permeate through the membrane in gallons per square foot per day), and M/F at the lowest pressure and highest flux rate. U/F is intermediate between the two. The membrane characteristics and operating parameters for each type of filtration are presented in Table 7-7.

R/O is relatively expensive to operate, and it can produce an effluent free of all but the lowest molecular weight pollutants. Because R/O systems are expensive to operate, and they produce an effluent of much greater quality than is necessary for pretreatment of industrial laundries wastewater, R/O is not used in the industry, so far as is known (18, 21). There is little mention in the literature of the application of R/O to industrial laundry wastewater, and consequently very little relevant data are available. Therefore R/O will not be discussed further in this document.

Microfiltration (also referred to as advanced membrane filtration) has been used to treat industrial laundries wastewaters and data are available in the literature (15, 22). Because M/F can pass relatively large sized pollutants it has been found necessary to chemically and physically treat the wastewater before application of M/F. At one industrial laundry the raw wastewater is chemically conditioned, solids are settled out, adsorbing or absorbing agents, or both, are added to aggregate the remaining pollutants before M/F. The result, after filtration, is an effluent of sufficient quality to recycle or even possibly to discharge directly to surface waters. M/F requires considerable preconditioning of the influent wastewater and, after conditioning, provides pretreated effluent of greater quality than usually required.

Since 1982, ultrafiltration has been installed in at least several industrial laundries to pretreat wastewater before discharge to the sewer. The literature contains some discussion of this technology (16, 23, 24), but the discussion and available data appear in conjunction with other technologies (e.g., carbon adsorption) to produce higher quality effluents than are required for pretreatment and discharge to a POTW. Wastewater data have been obtained for one U/F treatment system which is used to treat wastewater from washers dedicated to washing shop towels and printers' rags. These data were obtained during the present EPA study of the industrial laundries industry. The U/F system observed and the related analytical wastewater data obtained during the recent sampling episode are discussed in the following section.

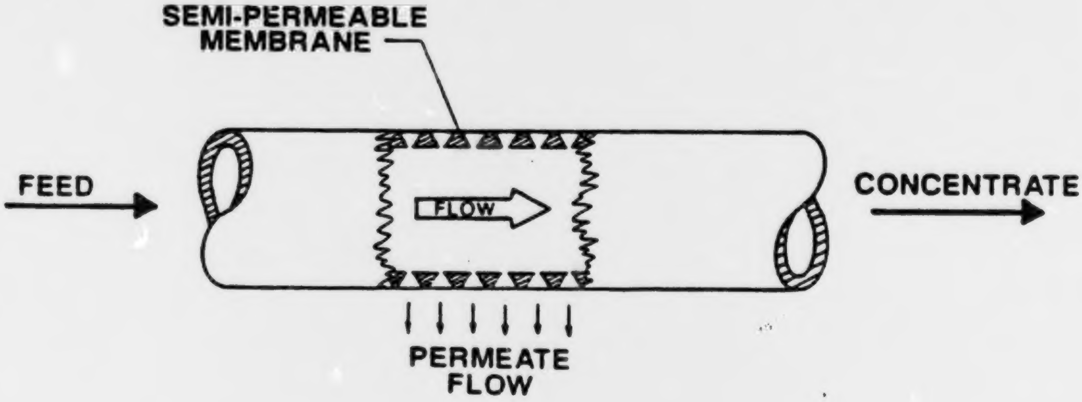
SEMI-PERMEABLE MEMBRANE
FEED
FLOW
CONCENTRATE
PERMEATE FLOW

FIGURE 7-2
CROSSFLOW MEMBRANE FILTER

TABLE 7-7

MEMBRANE FILTRATION CHARACTERISTICS AND OPERATING PARAMETERS

Type of Membrane	Pore Size[1] (μ)	Maximum Particle Size Passed Through Membrane (Molecular Weight)	Operating Pressure[1] (psi)	Flux Rate[1] (gal/ft^2/d)
Microfiltration	>0.1	100,000+	40-50	200-400
Ultrafiltration	0.0015-0.2	500-300,000	50-100	30-75
Reverse Osmosis	0.0001-0.0015	100-500	300-400	10-25

[1] Data are from Tran, T.V. (15).

7.2.3 Ultrafiltration Treatment Technology

As discussed previously, U/F is a crossflow membrane filtration process which, when applied to industrial laundry wastewaters, separates the wastewater stream into the permeate stream (which passes through the membrane) and a stream of concentrated pollutants (the concentrate). The permeate consists of water and other low molecular weight solvents and low molecular weight solutes, ranging from ionized metallic salts to organics, including some surfactants. The concentrate includes some water and other low molecular weight substances and relatively high concentrations of materials rejected by the membrane. These include suspended solids, emulsified oils, chelated metal ions, and a wide variety of organics selectively dissolved in the emulsified oils.

The key elements of the ultrafiltration system are the semipermeable membranes made of strong, relatively inert polymers. The polymers used for treating industrial laundries wastewaters must be able to withstand high pH, relatively high temperatures, and an otherwise harsh chemical environment. They are generally made from polysulfones or similar, proprietary polymers. The membranes have a anisotropic pore structure, with a thin dense layer (less than 1 micron thick) covering a more porous substructure. The thin layer faces the influent wastewater stream and has pore openings of 0.05 to 0.1 microns. The substructure has larger pores.

The membrane is constructed to offer minimum resistance to the water fraction of the wastewater stream but does not pass suspended solids and emulsified oils. The pores in the membrane are, in effect, generally cone shaped; with the smallest opening facing the wastewater flow. As a result of the membrane structure, and as a result of operation in a crossflow mode, large substances, which cannot permeate the barrier, do not plug the pores or disrupt operation of the system.

An ultrafiltration unit is manufactured by casting the membrane inside a porous support tube, which is placed inside a permeate collection tube. The ends of the tubes are sealed so that the influent waste steam flows into the center of the tubular membrane, through the length of the tube, and the remaining wastes exit as the concentrate stream. The water fraction having permeated the membrane is contained in the collection tube and flows from that shell to be collected separately from the concentrate. Typically the support tube is one-half or one inch in diameter and five to twenty feet long. An ultrafilter module consists of some number of these tubular units operating in series, in parallel, or both.

The principal components of an ultrafiltration treatment system capable of adequately treating industrial laundries wastewater include some method of removing gross solids and lint (either a settling basin or lint screen), an equalization or collection basin, some method for free oil removal, process water tank or tanks, the ultrafilter module, pumps, valves, gauges, and other monitoring equipment. One successfully operating system is configured as shown in Figure 7-3. Wastewater drains discontinuously from the washing machines into a collection pit, and it is pumped through a rotating lint screen, and then drains into an equalization basin of approximately 8 hours detention time. Free oil rises to the surface of the equalization basin and is skimmed from the top. Equalization is necessary to level-off the wide variations in both temperature and pollutant concentrations of the effluent from various wash and rinse cycles.

The wastewater is pumped discontinuously from the equalization basin into the ultrafiltration module which operates in a semibatch mode. The water is pumped into the process tank, which has approximately eight hours detention time. From the process tank the water is pumped continuously to the ultrafilter, the permeate from which is discharged continuously to the sewer, and the concentrate is returned to the process tank for recycle to the ultrafilter. When the level in the process tank drops below some preset level, or the level in the equalization basin goes above a preset level, wastewater is again transferred from the equalization basin to the process tank. The process is operated, and concentrate is accumulated in the process tank for a period of time ranging up to several weeks. Eventually the concentration of oils and solids in the concentrate becomes high enough to depress the flux rate through the membrane to a point where the ultrafilter can not process the wastewater fast enough. When this occurs, the influent to the process tank is stopped and the concentrate is "cooked down" (i.e., as much water as possible is removed) in the ultrafilter for a period of time (usually overnight). The final concentrate is then removed from the process tank for disposal, and the cycle is repeated.

Typical removal efficiencies for an ultrafiltration treatment system are given in the literature (19) in terms of oil and grease. Concentrate consisting of 40 to 60 percent oil and grease can be obtained from wastewater containing 1 to 5 percent oil and grease. The system operates most efficiently on emulsified oil. Free oil and grease tend to coat the filter tubes eventually and reduce the permeate flux, but is easily removed before filtration. The permeate may contain less then 0.005 percent oil and grease. The expected reduction in volume from influent feed stream to concentrate is 95 to 98 percent. The BOD$_5$ removal efficiency will vary, depending on the nature of pollutants present. The total suspended solids removal will also vary, but the level of suspended solids in the permeate will always be very low as nonfilterable solids can not pass through the membrane.

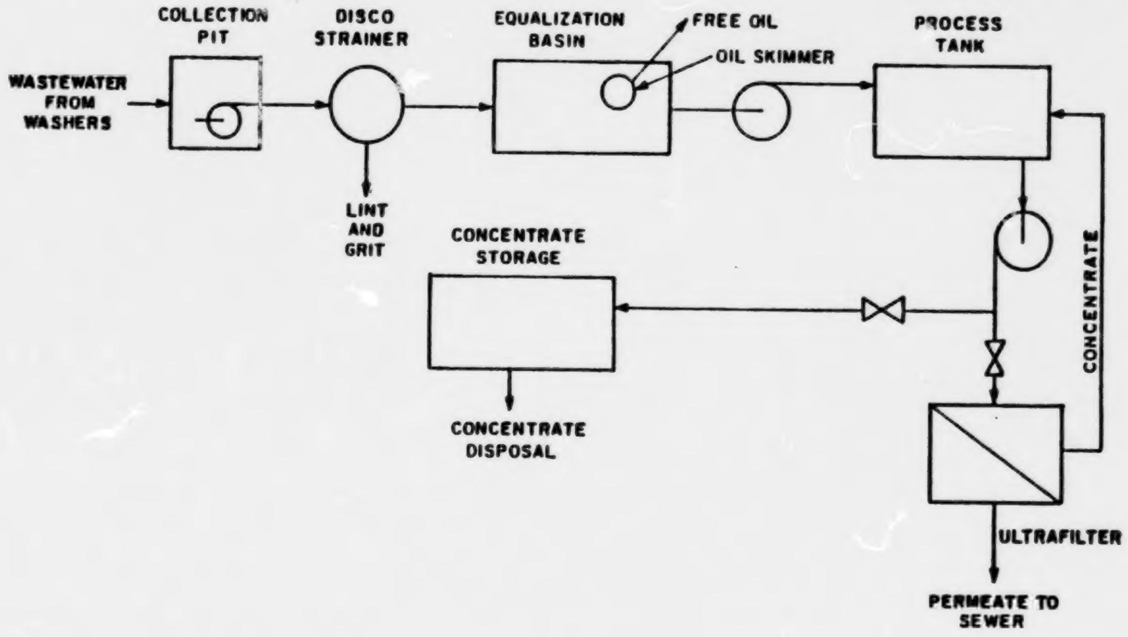
COLLECTION PIT
DISCO STRAINER
EQUALIZATION BASIN
FREE OIL
OIL SKIMMER
PROCESS TANK
WASTEWATER FROM WASHERS
LINT AND GRIT
CONCENTRATE STORAGE
CONCENTRATE
CONCENTRATE DISPOSAL
ULTRAFILTER
PERMEATE TO SEWER

FIGURE 7-3
ULTRAFILTER TREATMENT SYSTEM
FOR LAUNDRY WASTEWATER

Table 7-8 presents removal efficiencies for conventional, nonconventional, and priority pollutants by an U/F treatment system operated at an industrial laundry during the current EPA study. It should be noted, however that the treatment was not applied to the entire wastewater stream, but only the effluent generated from laundering shop towels and rags. This portion of the laundry's effluent contains higher concentrations of most pollutants than the remaining effluent and over one-half of the total mass loadings of the pollutants discharged. See Tables 4-1 and 5-12.

The data presented in Table 7-8 indicate the effectiveness of an ultrafilter in reducing the pollutant loading of laundry washwater. The ultrafilter operates in conjunction with a lint screen and an equalization basin with an oil skimmer. As expected, the system achieves removals of both total suspended solids and oil and grease that are greater than 99 percent. The reduction in BOD_5 is about 65 percent, and the reduction in COD is over 80 percent. The percent removals for most metals are over 75 percent and for the majority are over 95 percent. The removals for most volatile and semi-volatile organics are over 75 percent and usually over 95 percent. The percent removals of the remainder of the organics shown in Table 7-8 are zero percent but many of these were detected in the effluent and had detection limits in the influent greater than their detected effluent concentration. The high removals of semivolatile organics are undoubtedly because of their solubility in oil and grease as compounds in this size range would otherwise pass through the ultrafilter membrane. High concentrations of some volatile organic compounds in the ultrafilter concentrate demonstrate that these compounds are also removed in this fashion, although volatilization in the collection pit, the strainer, and the equalization basin is also to be expected. There are insufficient data to determine the predominant removal pathway.

The principle design criterion for U/F is the flux or volume of wastewater passing through the membrane per unit of membrane surface area per unit time (19). The flux is basically determined by membrane characteristics. It is an increasing function of the feed temperature and pressure, and a decreasing function of the pollutant concentration. Given the flux for available membranes and the quantity of wastewater to be processed, the area of membrane and the size of the U/F system required, can be determined. The operating pressure is determined by membrane costs, pumping costs, and other equipment manufacturing costs, and is usually in the range of 50 to 100 pounds per square inch. The operating temperature is usually the average discharge temperature of the washwaters.

Much fine tuning may be required to optimize the operation of an U/F treatment system on laundry wastewaters after the system is installed, but the most critical factor for continuous satisfactory operation is proper cleaning of the membranes. Although operating in the crossflow mode is self-cleaning to a large degree, build-up of oil and solid particle concentrations occurs at the membrane surface as water permeates the membrane.

TABLE 7-8
SUMMARY OF REMOVAL EFFICIENCIES FOR SELECTED POLLUTANTS[1] BY ULTRAFILTRATION APPLIED TO SHOP TOWEL WASHER WASTEWATER

	Day 1		Day 2	
	Raw Waste (mg/ℓ)	Percent Removal	Raw Waste (mg/ℓ)	Percent Removal
Volatile Organic Compounds				
acetone	--		1.466	0
chlorobenzene*	--		0.142	100
ethylbenzene*	36.031	100	0.638	100
methylene chloride*	39.933	98	--	
tetrachloroethene*	55.516	99	3.403	83
toluene*	**	0	11.594	75
trans-1,2-dichloroethene*	0.713	100	--	
trichloroethene*	--		0.064	100
1,1-dichloroethene*	1.087	100	--	
1,1,1-trichloroethane*	38.331	99	0.691	22
2-butanone	**	0	**	0
2-chloroethylvinyl ether*	--		0.108	100
Semi-volatile Organic Compounds				
alpha terpineol	16.798	96	--	
benzidine*	22.436	100	--	
bis(2-ethyhexyl)phthalate*	9.441	100	--	
isophorone*	--		***	0
n-decane	30.652	100	--	
n-hexadecane	--		17.456	100
n-octadecane	--		22.089	100
naphthalene*	5.025	92	--	
o-cresol	--		***	0
p-cymene	8.111	100	--	
4-chloro-3-methyl phenol*	***	0	***	0

TABLE 7-8 (continued)

	Day 1		Day 2	
	Raw Waste (mg/ℓ)	Percent Removal	Raw Waste (mg/ℓ)	Percent Removal
Pesticides/Herbicides				
endosulfan Sulfate*	2.152	100		
EPN	5.529	100		
Metals				
aluminum	19.300	96	11.300	94
barium	4.480	99	2.620	100
boron	1.740	0	0.819	0
cadmium*	0.856	99	0.365	100
calcium	62.000	86	43.800	84
chromium*	1.170	79	0.815	79
cobalt	0.795	100	0.319	100
copper	9.070	99	7.690	99
iron	114.00	99	65.600	99
lead*	20.500	98	15.400	98
magnesium	18.500	98	10.300	100
manganese	1.950	100	1.210	100
molybdenum	1.270	80	0.369	0
nickel*	1.610	95	0.693	88
sodium	723.000	0	827.00	21
tin	0.536	100	0.808	100
titanium	0.574	100	0.244	100
vanadium	0.113	100	0.056	100
zinc*	13.100	99	9.480	99
antimony*	0.213	0	0.369	51
silver	0.877	100	--	

TABLE 7-8 (continued)

	Day 1		Day 2	
	Raw Waste (mg/ℓ)	Percent Removal	Raw Waste (mg/ℓ)	Percent Removal
Conventional and Other Pollutants				
residue, filterable	2,000	0	11,000	72
residue, non-filterable	4,700	100	4,200	100
cyanide, total*	0.110	0	0.130	0
fluoride	2.8	0	NR	
ammonia, as N	1.9	100	--	
nitrogen, kjeldahl, total	5.0	0	4.2	0
nitrate-nitrite, as N	0.47	0	1.4	69
total phosphorus, as P	1.9	0	7.0	0
BOD-5 day (carbonaceous)	2,200	65	2,900	66
chemical oxygen demand	10,000	81	11,000	82
oil and grease total recoverable	4,500	100	7,700	99
total organic carbon	750	33	1,200	60
sulfide, total (iodometric)	NR		5.8	43

* Priority pollutant

-- Indicates pollutant concentration less than the detection limit or less than 50 µg/ℓ, whichever is greater

NR No data reported due to matrix interference

** Found in the effluent but not detected in the influent

*** Found in the effluent. Detection limit in the influent is greater than the effluent concentration

¹ Pollutants shown here are those found at concentrations of greater than 0.05 mg/ℓ in the ultrafilter influent or effluent.

Eventually there is some adhesion to the surface. As particles aggregate on the membrane surface, a drop in flux rate occurs. To maintain the flux rate it is necessary to clean the membranes periodically. Cleaning can be done mechanically by forcing sponge balls through the membranes under pressure, or chemically with detergents or solubilizing agents, or some combination of these three methods. The frequency of cleaning (usually once or twice per week) and the methods used will depend on the nature of the wastewater being treated.

The end result of ultrafiltration treatment is two streams. One is a high quality permeate stream containing water, sundry ionic pollutants, and relatively low molecular weight organic pollutants. The permeate of the laundry sampled during the current study was well within limits acceptable to the POTW. The second stream, the concentrate, is two to five percent of the treated wastewater in volume. The concentrate consists of solids (lint and other fine particles) and an oil-water emulsion. The literature reports that concentrations as high as 40 to 60 percent oil can be obtained in the concentrate. The laundry sampled during this study reports that their concentrate contains about 50 percent water, 25 percent oil, and 25 percent solids, but analyses of samples collected by EPA were found to have much lower percentages of oil and solids (3 percent oil, 6 percent solids; see Table 5-12).

The permeate from treated laundry wastewaters can be discharged to the sewer, but the concentrate must be disposed of otherwise. The concentrate from the laundry sampled is considered to be a hazardous waste and is disposed of by a contract hauler. It has been landfilled in the past, but the considerable cost of disposing of hazardous wastes by landfill has induced the laundry to attempt to break the oil-water emulsion into separate oil and water fractions. When this is done the considerable water fraction need not be hauled away as a hazardous waste. It can probably be returned to the treatment system. Breaking (generally called cracking) the emulsion can be accomplished by mixing the emulsion with a strong acid. If the crack is successful the emulsion will divide into an oil fraction and a water fraction (and probably, in the case of laundry wastewater, also a solids fraction). The facility has not yet found an entirely satisfactory method of cracking the emulsion. By separating the water fraction, disposal costs will be reduced; less volume will have to be transported, and probably the oil-lint fraction can be incinerated, a less costly disposal method than landfilling.

ECONOMIC IMPACT ANALYSIS

SECTION 8

8.0 INTRODUCTION TO THE ECONOMIC IMPACT STUDY

Sections 8 through 11 of this document present an outline and the results of a study of the economic characteristics of the industrial laundries industry. The purpose of the study was to determine the economic health of the industry and the likely economic impact on the industry of governmental regulations on industrial laundries wastewater discharge.

8.1 Introduction

This industry profile and preliminary economic impact analysis is divided into four sections:

- Section 8 provides an introduction and a brief review of the goods and services provided and the processes employed by the industry.
- Section 9 describes the characteristics of and recent trends in the industry. Section 9.1 describes the number of firms and establishments. Section 9.2 presents data on industry revenues. Section 9.3 discusses employment and wages in the industry. Section 9.4 presents data on revenues per employee, a measure of productivity in the industry.
- Section 10 presents financial characteristics of firms in the industry, and analyzes the potential impacts on industrial laundry profits of a requirement for an ultrafiltration pretreatment system for laundry wastewater.
- Section 11 describes influences on the industry, including competition, the availability of substitute goods and services, and environmental regulation.

There were approximately 1,200 industrial laundry establishments in the United States in 1985 (26, 1985, 1986), owned by 800 firms (27), with total employment of approximately 55,000 (largely unskilled and semi-skilled laborers) (26, 1985, 1986). Total 1985 industry revenues were approximately $2.4 billion (27; 26, 1985, 1986), and total wages paid out equalled about $800 million (26, 1985, 1986).

The industrial laundries industry has grown very little in the past 25 years. Revenue growth has been only about 1 percent per year (in constant dollars). Because new entrants have joined the industry, revenues per establishment have actually declined. The industry has contracted along with America's industrial base in the Northeast and Midwest, and has expanded only in a few states in the South and West.

8.2 Nature of Laundry Services and Processes

The industrial laundries industry provides goods and services to commercial and industrial customers in three primary areas:

- Clean work apparel (uniforms and other work clothes).
- Shop towels and wiping cloths.
- Floor mats and dust mops.

The industry engages primarily in rental service. Articles are owned by the industrial laundry firm and rented to its customers. On a regular schedule, the industrial launderer delivers cleaned articles to each client firm and picks up soiled articles and returns them to his plant for laundering.

Historically, the industry's primary customer base has been among manufacturing industries, particularly those associated with the automobile (including auto service stations and dealerships). However, the industrial laundry clientele has mirrored the gradual shift in the American economy away from heavy industry and toward service-based commercial and light industrial concerns. Today more than 40 percent of the garments rented by the industry are placed in commercial and industrial environments not subject to heavy soil conditions (28, p. 11).

The industry relies primarily on water-based cleaning techniques. Through the early 1970s, dry cleaning technologies were also heavily employed in the industry, but their use has declined rapidly in the past decade. Although the industry has witnessed the partial or complete automation of many processes, it remains relatively labor-intensive, relying on unskilled or semi-skilled laborers to perform the relatively routine tasks associated with the laundering process.

This section provides an overview of the goods and services provided by the industrial laundry industry and of the laundering processes it employs. Section 8.1 describes the three classes of articles which are the industry's major products (garments, shop towels, and dust control articles). Section 8.2 provides a brief description of the cleaning processes employed. Both sections provide information on recent trends within the industry.

8.2.1 Services Provided. Table 8-1 shows the distribution of revenues from the major classes of goods and services provided by the industrial laundries industry in 1985. Table 8-2 provides additional information on some of the minor industry revenue sources in 1982.

More than half of 1985 industry revenues were earned by garment rental and laundering services. Floor mats and dust mops and cloths accounted for approximately 14 percent of revenues, while shop towels and wiping cloths contributed nearly 10 percent of revenues. Additional revenues are provided by the direct sale of garments and other goods (5 percent) and by miscellaneous services such as rental and laundering of linens, miscellaneous commercial laundering and dry cleaning, rug and carpet cleaning, and others. Tables 8-3 and 8-4 show the growth rates of the major industrial laundry market segments from 1978 through 1984.

Growth has been relatively even across these categories; the only market segment which has consistently grown faster than the industry average is the floor mat category, which has grown to account for over 10 percent of 1985 industry revenues.

8.2.2 Processes Employed. This section provides only a very brief overview of the cleaning processes employed by industrial launderers. More complete information has been presented in Section 3 of this report.

Two basic processes (water washing and dry cleaning) account for nearly 95 percent of the poundage washed by industrial launderers. A third process (dual-phase laundering) combining both water wash and solvent wash (dry cleaning) cycles, is used on less than 5 percent of industrial laundry volume. A fourth nonaqueous process may be employed to clean and treat dust mops in an oil bath, the residue of which retains dust collected on the mops.

Materials to be laundered are sorted into batches to receive similar processing. The laundering process consists of a series of wash cycles separated by rinses. The washes employ different combinations of detergents, pH, temperature, and agitation, depending on the nature of the garments and soils. After washing, most garments are finished by means of automatic or semi-automatic steam saturation and air drying processes. Shop towels, dust cloths, and floor mats are finished by tumble drying and folding.

Most of the labor involved in the industry is related to sorting of articles before and after the wash cycles and to transferring batches of articles among machines. The most modern equipment has automated virtually the entire wash process, but the industry has been relatively slow to take advantage of modernization and automation.

Water washing is by far the dominant process employed by industrial laundries, accounting for over 80 percent of the volume of articles washed. Dry cleaning follows many of the same steps as water washing, but articles are cleaned in an organic solvent instead of an aqueous detergent solution. Dry cleaning accounts for 10 to 15 percent of the poundage cleaned by industrial launderers, and this proportion is decreasing.

TABLE 8-1

DISTRIBUTION OF REVENUE FROM INDUSTRIAL LAUNDRY PRODUCTS AND SERVICES, 1985[1]

Product/Service	Percent of 1985 Industry Revenues
Garment Rental and Laundering	52.6
Shop Towels	9.4
Mats	10.5
Dust Mops/Cloths	3.7
Direct Sale of Garments, Mats, etc.	5.0
Other Products/Services (including Linens)	18.8

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[1] Data only from member firms of the Institute of Industrial Launderers

Source: Institute of Industrial Launderers (28)

TABLE 8-2

PERCENT DISTRIBUTION OF RECEIPTS FROM MAJOR SOURCES IN 1982

Source	Percent of Total Revenues
Coin operating laundry and dry cleaning (store)	1
Drycleaning work (except coin operated, industrial, and rug)	1
Family and bachelor laundry work	1
Commercial laundry work	1
Industrial laundry/dry-cleaning work and rental	
Garments	60
Wiping cloths and dust control materials	24
Laundry work and rental	
Linen garments and full dry linens	3
Linen flatwork	5
Carpet and upholstery cleaning	1
Sales of disposables and other merchandise	3
Other sources	2
TOTAL	100

Total Number of Establishments: 1,288
Total Value of receipts: $1,895 million

Source: 1982 U.S. Census of Service Industries, Industry Series, U.S. Department of Commerce

TABLE 8-3

INDUSTRIAL LAUNDRY MARKET SEGMENT REVENUE GROWTH RATES, 1978 TO 1984[1]

Market Segment	Year 1984[2] %	 1983 %	 1982 %	 1981 %	 1980 %	 1979 %	 1978 %
Garments	12.8	7.4	6.1	8.1	9.2	16.6	14.4
Shop Towels	17.4	5.9	6.1	8.4	15.3	18.7	11.5
Floor Mats	17.1	9.6	16.4	18.5	26.7	21.8	17.8
Dust Mops and Cloths	7.6	6.9	9.0	8.8	14.3	16.1	5.7
Direct Sale and Other	10.5	9.2	1.9	14.1	11.4	17.2	18.2
Total	12.9	7.9	6.1	10.5	11.8	17.3	14.9
GNP Price Deflator	3.8	3.9	6.4	9.7	9.0	8.9	7.3

[1] Growth rates expressed in current year, or inflated, dollars

Data from member firms of Institute of Industrial Launderers only

[2] 1984 growth rate is estimated based on preliminary data

Source: Institute of Industrial Launderers (28, 29), and EPA estimates based on raw data presented in these documents.

TABLE 8-4

INDUSTRIAL LAUNDRY MARKET SEGMENT REVENUES AND GROWTH, 1978 TO 1985

Market Segment	Year 1985	1984	1983	1982	1981	1980	1979	1978
Industry Revenues by Market Segment								
Garments	1,288	1,142	1,063	1,002	927	849	728	637
Shop Towels	230	196	185	175	161	140	118	106
Floor Mats	257	220	200	172	145	115	94	80
Dust Mops and Cloths	91	84	79	72	66	58	50	47
Direct Sale and Other	583	527	483	474	415	372	318	269
Total	2,449	2,169	2,011	1,895	1,715	1,534	1,308	1,138
Share of Revenues by Market Segment								
Garments	52.6%	52.6%	52.9%	52.9%	54.1%	55.4%	55.7%	55.9%
Shop Towels	9.4%	9.0%	9.2%	9.2%	9.4%	9.1%	9.0%	9.3%
Floor Mats	10.5%	10.1%	10.0%	9.1%	8.5%	7.5%	7.2%	7.0%
Dust Mops and Cloths	3.7%	3.9%	3.9%	3.8%	3.9%	3.8%	3.8%	4.2%
Direct Sale and Other	23.8%	24.3%	24.0%	25.0%	24.2%	24.3%	24.3%	23.6%
	100%	100%	100%	100%	100%	100%	100%	100%

Note: 1978 to 1981 growth rates are ERG estimates

Source: Institute of Industrial Launderers (28, 29), and EPA estimates based on raw data presented in these documents.

SECTION 9

9.0 INDUSTRY CHARACTERISTICS AND TRENDS

The most recent, relatively comprehensive, collection of statistics for this industry was published in the 1982 Census of Service Industries (12). Some data on employment, payrolls, and establishment size are published annually in the U.S. Census Bureau's County Business Patterns series, and additional data are collected by the industry's trade association (the Institute of Industrial Launderers, or IIL). The picture that emerges from these data is of a small, relatively static industry, which has exhibited little growth over the past 20 years.

9.1 Number and Size of Firms and Establishments

In 1982 the U.S. Census Bureau reported that 1,288 industrial laundry establishments were in operation in the United States. These are owned by approximately 800 firms (27).

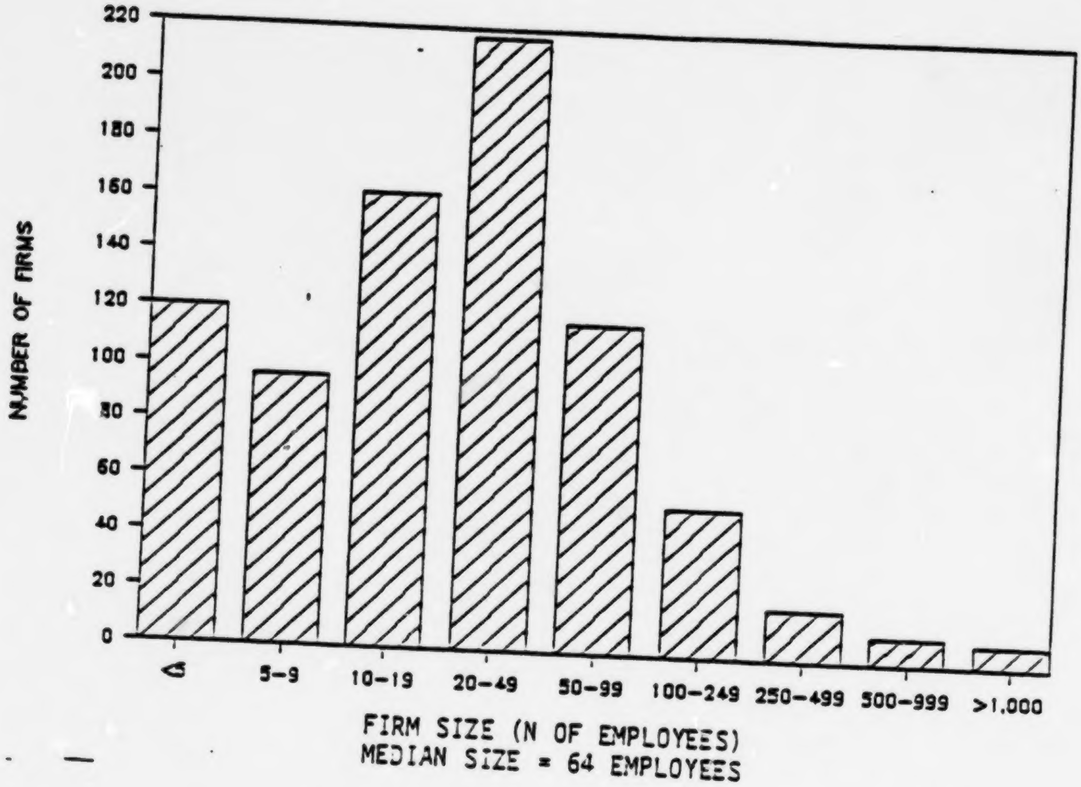
Figures 9-1 and 9-2 display the distribution of firms by size class in 1982. The mean size of all firms in the country in 1982 was 64 employees; mean revenues per firm were approximately $2.3 million. As Figures 9-1 and 9-2 show, however, these averages are skewed by the presence in the industry of a small number of very large firms. The industry is actually characterized by the existence of a large proportion of relatively small firms. For example, 44 percent of all firms generated 1982 revenues of less than $500,000, and 63 percent generated revenues of less than $1 million. Only 16 percent of all firms generated revenues greater than $2.5 million. Similarly, over a quarter of all firms employed less than 10 employees, and nearly half employed less than 20 employees. (Large firms, however, are responsible for the bulk of revenue generation and employment in the industry [see Section 9.2]).

The mean size of all industrial laundry establishments in 1982 was 40 employees (Figure 9-3); mean revenues were approximately $1.5 million per establishment (Figure 9-4). Again, these data mask the significant numbers of small establishments in the industry; over 40 percent of all establishments had less than 20 employees, and over half generated revenues of less than $1 million per year.

Industrial laundry establishments are concentrated in the nation's metropolitan areas, and exhibit significant regional clustering. California and Texas contain 11.5 percent and 9.7 percent of all establishments, respectively (Figure 9-5). Six of the next seven states (New York, Ohio, Illinois, Michigan, Pennsylvania, and Indiana) are in the industrialized Northeast and Midwest. Between them, the top nine states (including Florida in addition to those above) account for approximately 53 percent of all establishments.

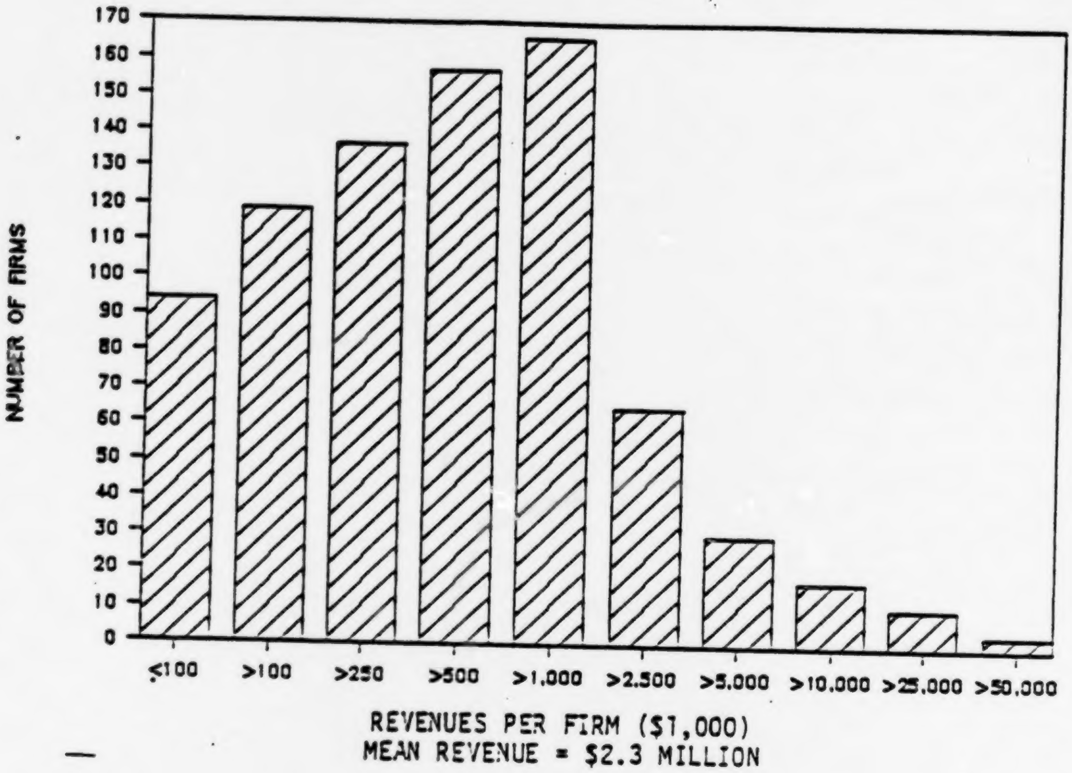
9.1.1 Trends. Between 1967 and 1982, the number of establishments in the industry grew from 918 to 1,288 (28).

(Comparisons with 1985 data are not valid because data were collected by different agencies.) This growth was not uniform across the country, however. Figure 9-6 displays the number of establishments by EPA region for the years 1967, 1972, 1977, and 1982. EPA Regions 1 and 2 accounted for almost 20 percent of all establishments operating in 1967 (175 out of 901), but have experienced virtually no growth since then. Regions 4 and 9 accounted for the bulk of industry growth from 1967 to 1977, while Regions 5 and 6 also witnessed rapid expansion in the number of establishments from 1977-1982.



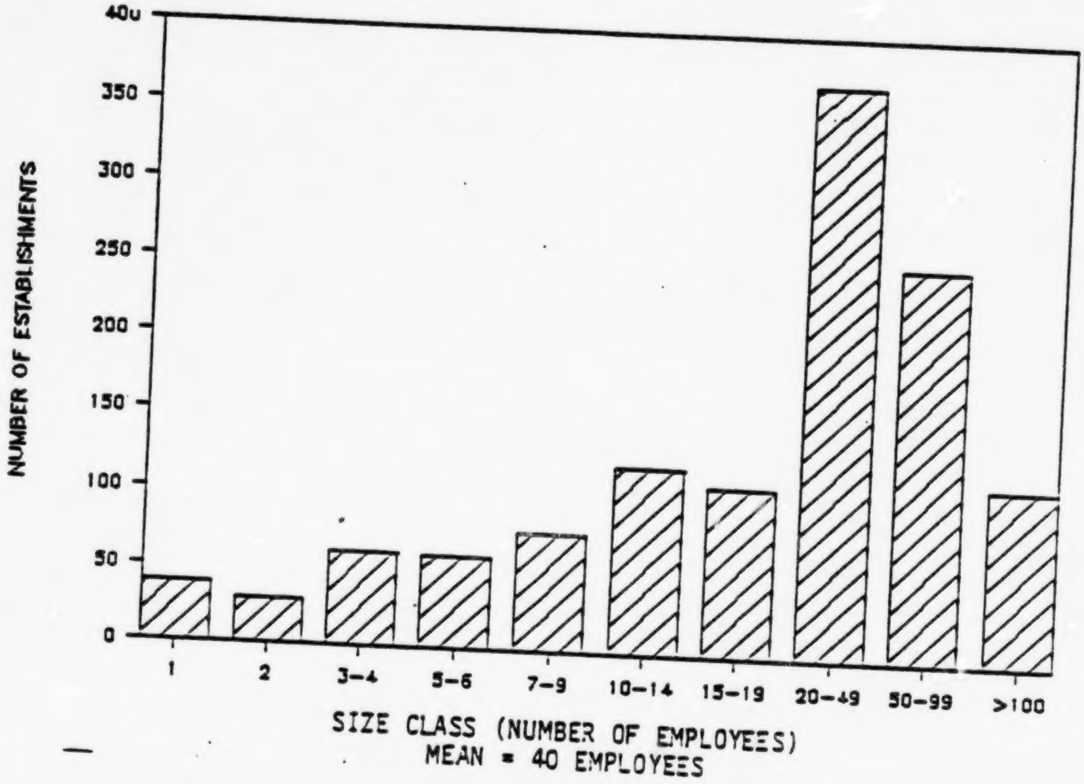
Source: U.S. Census Bureau 1982

Figure 9-1 Number of industrial laundry firms by firm employment, 1982.



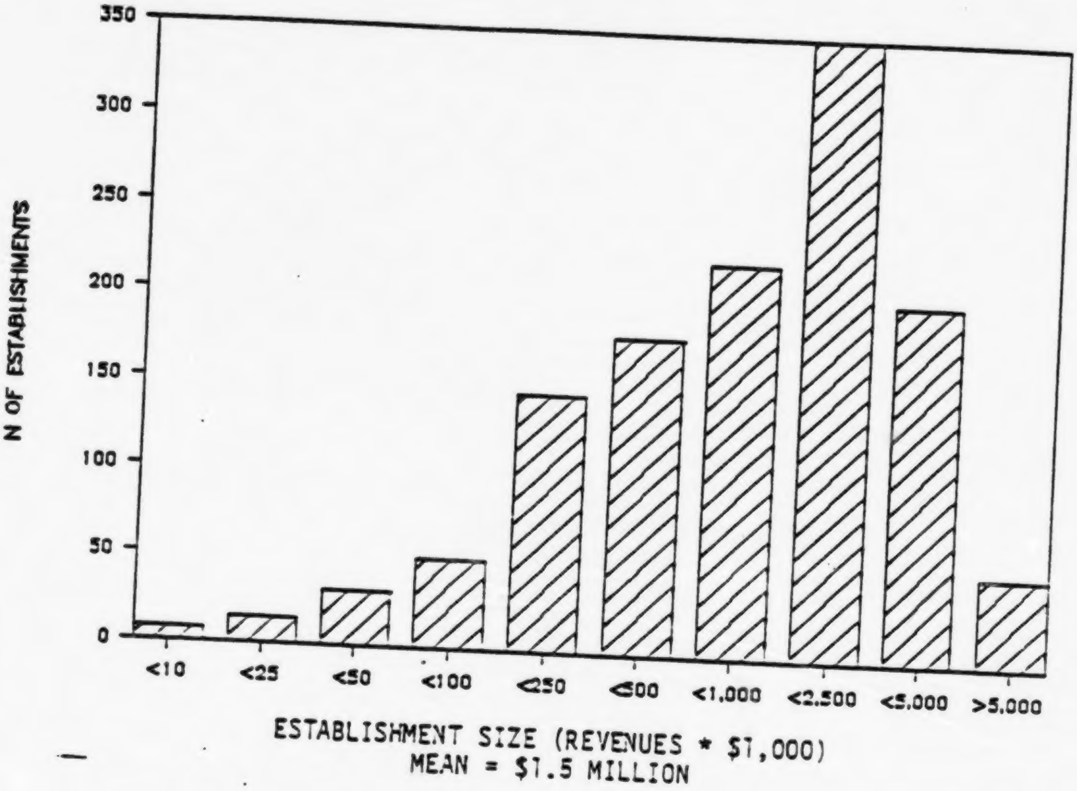
Source: U.S. Census Bureau 1982

Figure 9-2. Number of industrial laundry firms by firm revenues, 1982.



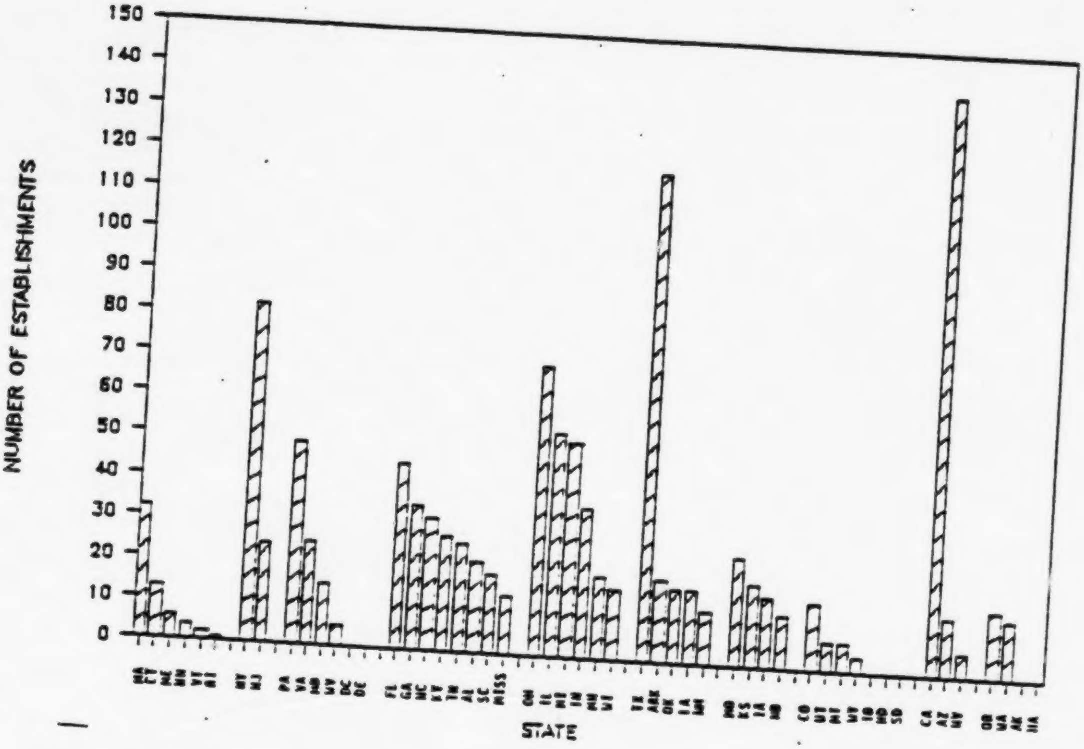
Source: U.S. Census Bureau 1982

Figure 9-3 Number of industrial laundry establishments by establishment employment, 1982.



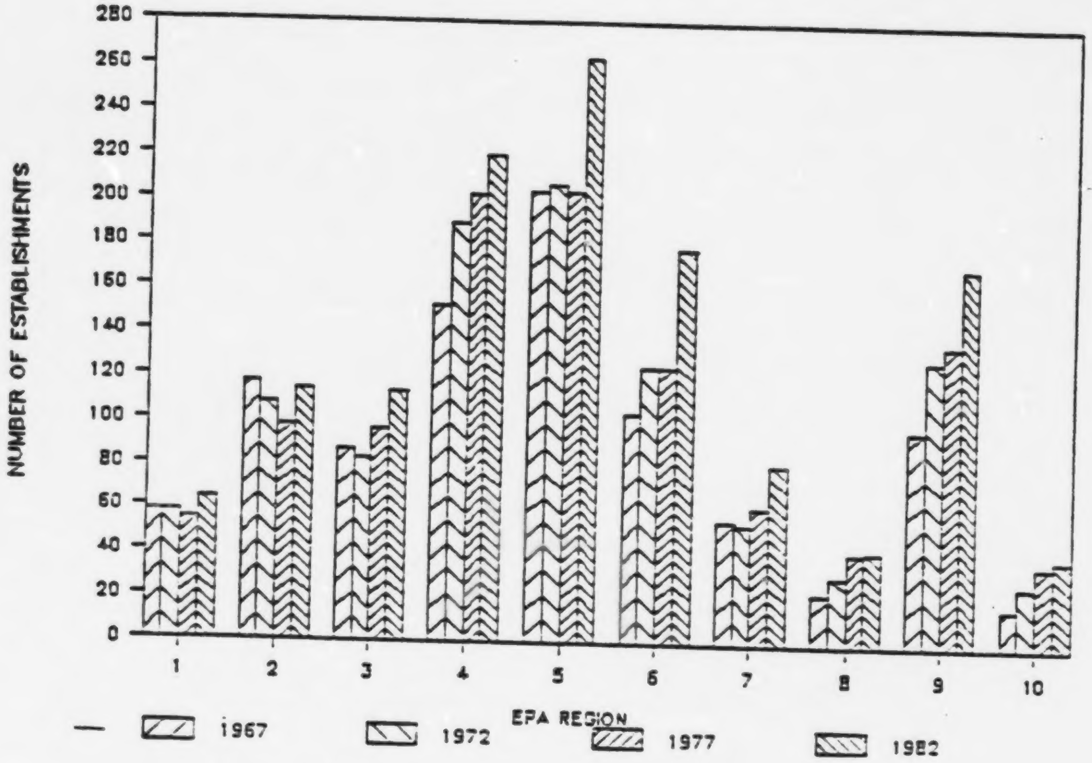
Source: U.S. Census Bureau 1982

Figure 9-4. Number of industrial laundry establishments by establishment revenues, 1982.



Source: U.S. Department of Commerce 1985, 1986

Figure 9-5 Number of industrial laundry establishments by state, 1985.



Source: Industrial Laundry Industry and its Markets (29), based on U.S. Census Bureau, Census of Service Industries

Figure 9-6 Number of industrial laundry establishments, 1967-1982.

Figure 9-7 (based on a consistent series of County Business Pattern data) plots the percent of all establishments in each of eight size classes for 1978, 1982, and 1985. There have been no discernible trends over the eight years represented.

9.2 Industry Revenues

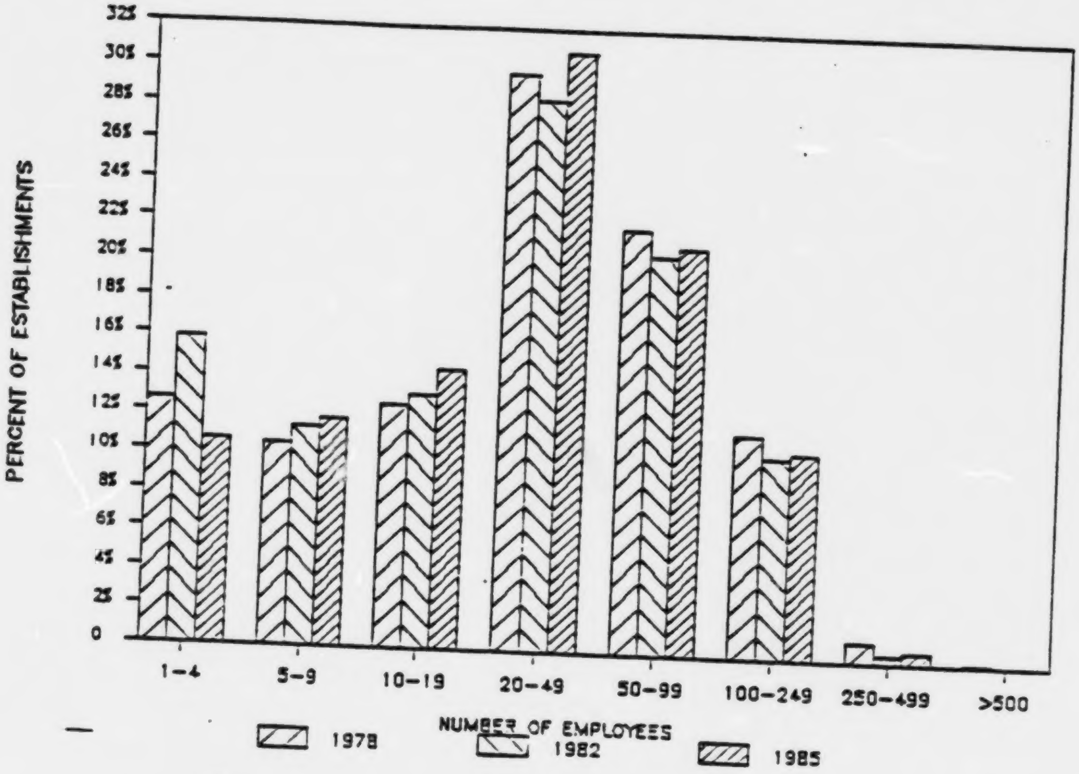
Industrial laundries generated revenues in 1982 of approximately $1.9 billion. In 1985 revenues were $2.4 to $2.5 billion (27; 26, 1985, 1986). Although the large majority of firms and establishments in the industry are small (see Section 9.1), larger firms/establishments generate the majority of revenues in the industry. For example, the 2 percent of all firms with 1982 revenues greater than $25 million per firm accounted for nearly 40 percent of industry revenues (Figure 9-8).

A similar concentration of revenue generation is apparent in data on individual laundry establishments (Figure 9-9). Over 55 percent of total 1982 revenues were generated by establishments with revenues greater than $2.5 million; 66 percent of industry revenues were generated by the 369 establishments (29 percent of all establishments) with 50 or more employees (27).

9.2.1 Trends. In constant (1982) dollars, industry revenues grew by only 14 percent between 1967 and 1982, from $1.66 billion to $1.90 billion (29, based on U.S. Census Bureau, Census of Service Industries for 1967, 1972, 1977, and 1982). Revenue growth was thus less than 1 percent per year. Revenue growth has apparently been higher since 1982, approximately 8 percent per annum in nominal terms (26, 1982, 1986). This estimate relies on the comparability of data from the 1982 Census of Service Industries and that from the annual County Business Patterns. In fact, comparability is uncertain because different methodologies are used in the two documents.

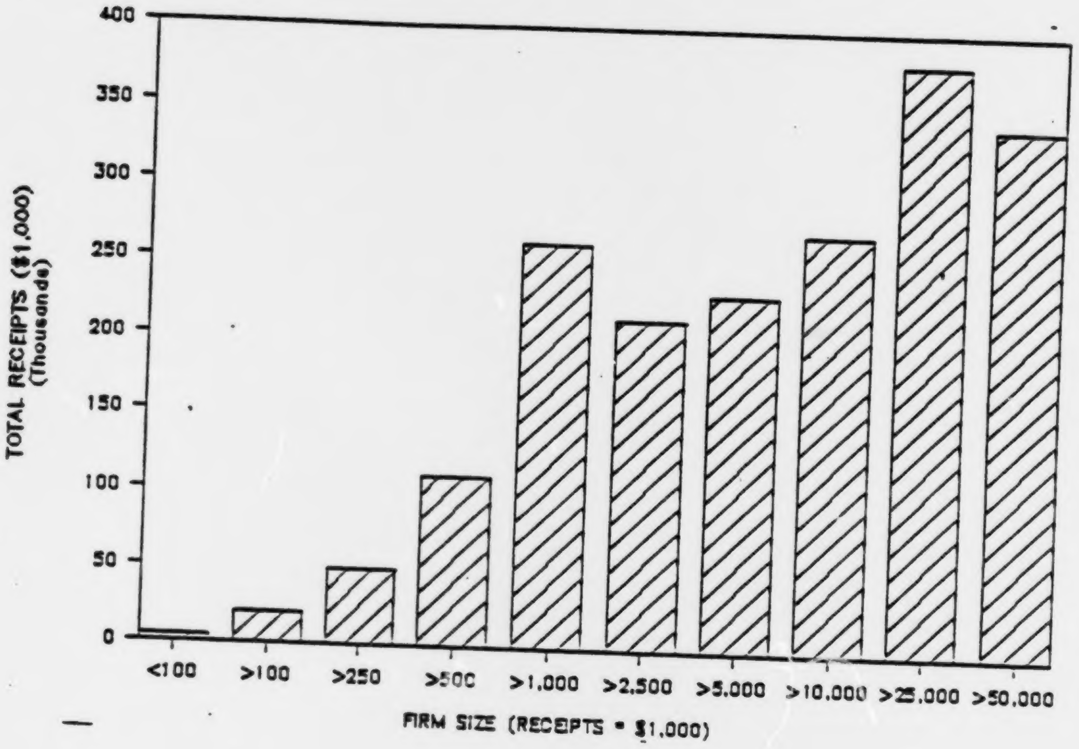
Revenues contracted in four EPA regions in the Northeast (EPA Regions 1 and 2), Mid-Atlantic states (Region 3), and Midwest (Region 5) from 1967 through 1982, although the Midwestern states (Region 5) continued to lead the industry in terms of total revenues generated (Figure 9-10). Significant growth in revenues occurred only in the Southeast (Region 4), the West South Central states, particularly Texas (Region 6), and in California (Region 9).

Because the number of establishments in the industry grew at a faster rate than revenues between 1967 and 1982, revenues per establishment (in constant 1982 dollars) declined noticeably during these years. Nationally, revenues per establishment declined nearly 20 percent, from $1.81 million in 1967 to $1.47 million in 1982 (Figure 9-11). Nearly all regions of the country were affected by this trend. Most affected was EPA Region 1, where revenues per establishment declined by over 50 percent. Region 8 was the only region to buck this trend; this region also had, by far, the lowest revenues per establishment throughout the period 1967 to 1982.



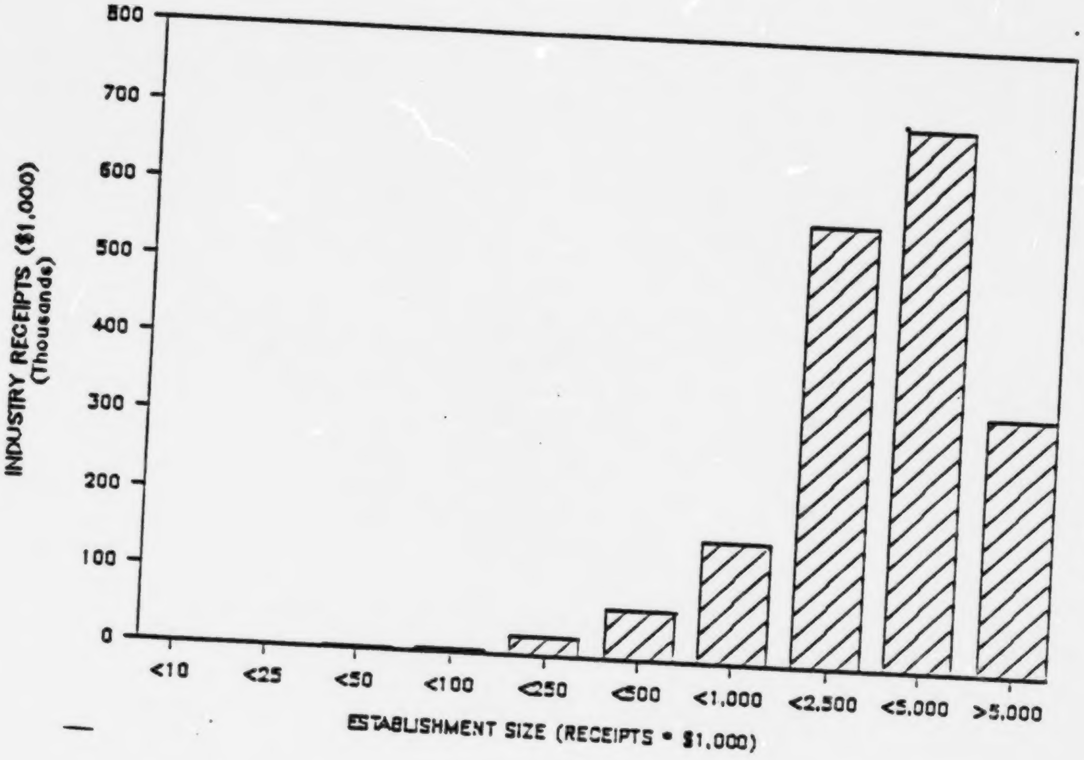
Source: U.S. Department of Commerce, County Business Patterns, 1978, 1982, and 1985

Figure 9-7 Number of industrial laundry establishments by establishment employment, 1978-1985.



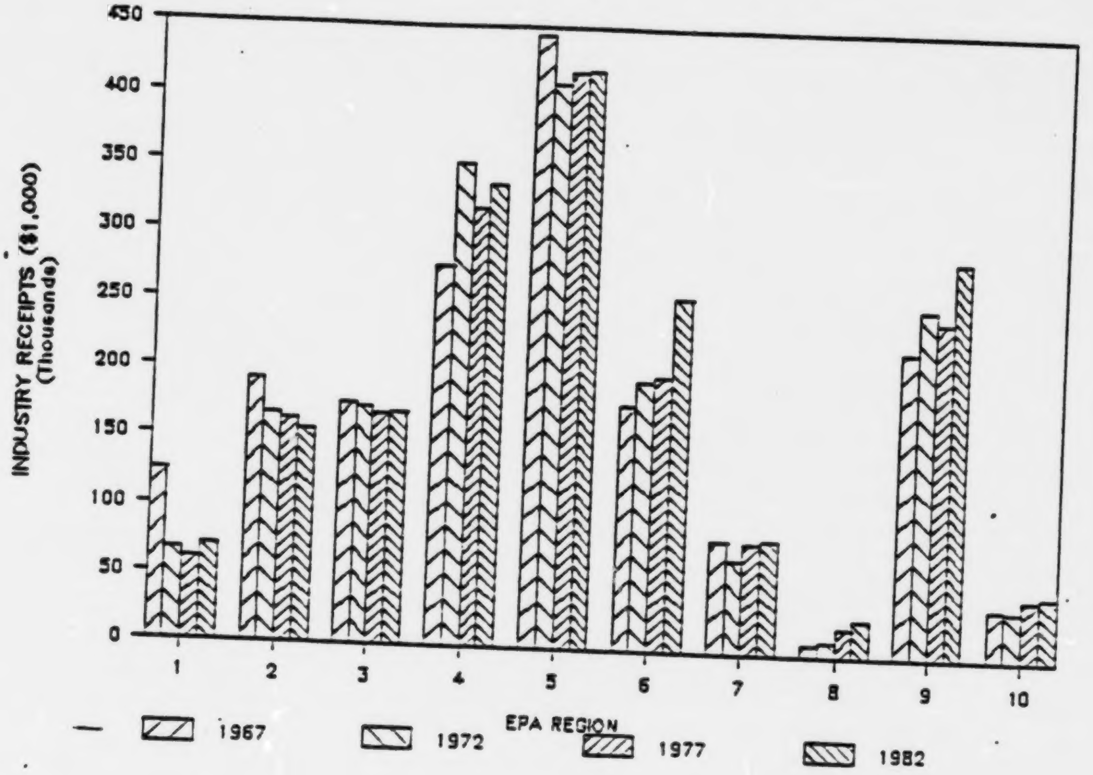
Source: U.S. Census Bureau 1982

Figure 9-8 Total industrial laundry receipts by firm revenues, 1982.



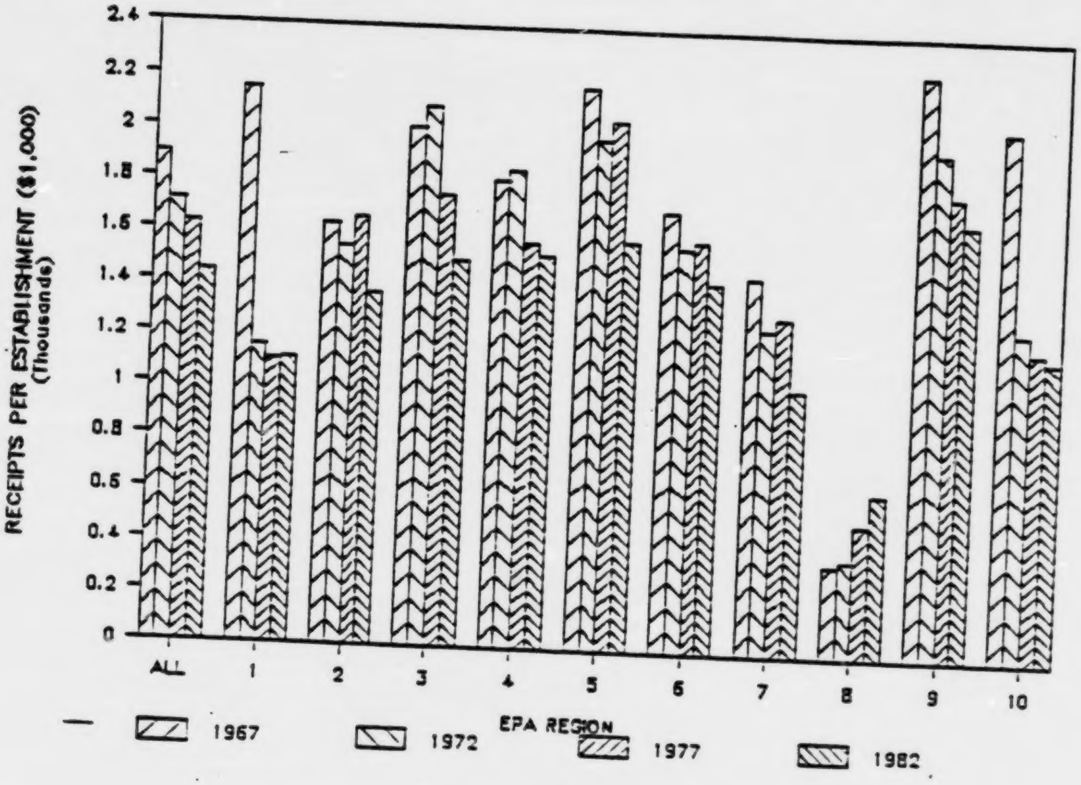
Source: U.S. Census Bureau 1982

Figure 9-9 Total industrial laundry receipts by establishment revenues, 1982.



Source: Industrial Laundry Industry and its Markets (29), based on U.S. Census Bureau, Census of Service Industries

Figure 9-10 Industrial laundry revenues (constant dollars), 1967-1982.



Source: Industrial Laundry Industry and its Markets (29), based on U.S. Census Bureau, Census of Service Industries

Figure 9-11 Industrial laundry revenues per establishment (constant dollars), 1967-1982.

9.3 Revenues by Market Segment

Rental and laundering of garments accounted for over 50 percent of industrial laundry revenues in 1985 (Table 8-1). Floor mats contributed 10.5 percent to revenues, shop towels 9.4 percent, and dust mops and cloths 3.7 percent. Direct sales of garments, floor mats, and other items accounted for 5 percent of revenues, while miscellaneous other services (e.g., linen rental and laundering) accounted for approximately 19 percent of revenues (28)

9.3.1 Trends.

Table 8-4 presents approximate industry revenues by market segment for 1978 through 1985. The distribution of revenues by market segment has remained fairly constant over this period; the market share for garments has declined by a few percent, and only the floor mat category has exhibited significant growth. The values in Table 8-4 are in current year (inflated) dollars, and thus do not reflect real revenue growth. Also, these data are from member firms of the Institute of Industrial Launderers, which may over-represent the larger and more successful firms in the industry.

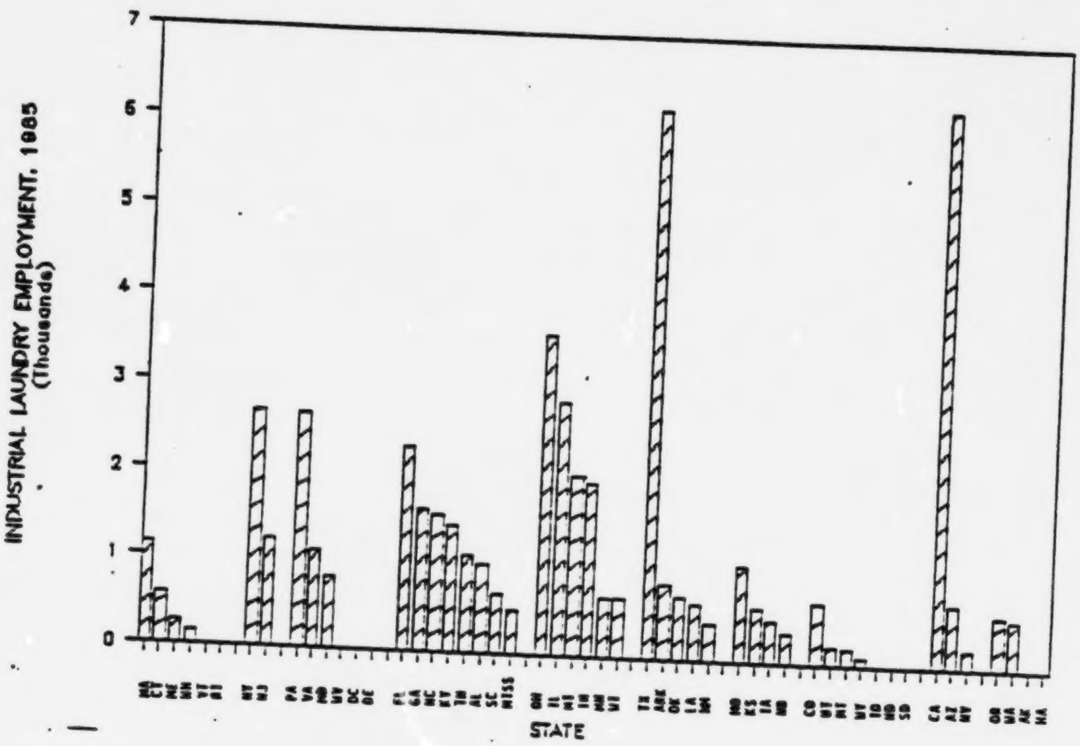
9.4 Employment and Wages

Total 1985 employment by industrial laundries nationwide was approximately 54,000 workers (including management and clerical employees) (26, 1985, 1986). The total industry payroll was approximately $800 million (26, 1985, 1986). The mean salary in the industry was approximately $14,800. There is very little part-time employment in this industry (30).

Figure 9-12 displays industrial laundry employment by state. Texas and California each account for over 11 percent of all industry employees. Employment is also concentrated in New York, Pennsylvania, Florida, Ohio, Illinois, Michigan, and Indiana. Between them, these top nine states account for 57 percent of total industry employment. With the exception of California and Texas, Figure 9-12 reflects again the concentration of the industry in the heavily industrialized states running from New York and Pennsylvania west to Illinois.

Total industry employment reflects the dominance of larger firms and establishments in the industry. For example, while firms with less than 20 employees include almost 45 percent of all firms in the industry, they account for only 6 percent of industry employment. The 37 percent of all firms with revenues over $1 million account for over 86 percent of industry employment. For individual establishments, the 20 percent of all establishments with receipts over $2.5 million account for over 50 percent of industry employment.

Census Bureau data indicate that payroll equals approximately 35 percent of receipts for all industrial laundry establishments. There is no consistent trend in these data related to establishment size.



Source: U.S. Department of Commerce 1985, 1986

Figure 9-12 Total industrial laundry employment by state, 1985.

9.4.1 Trends. As noted, employment in 1985 was reported at 54,000. The employment total in 1967 was 45,000. The industry thus exhibited an annual growth rate in employment of only approximately 1 percent per year for the period 1967-1985.

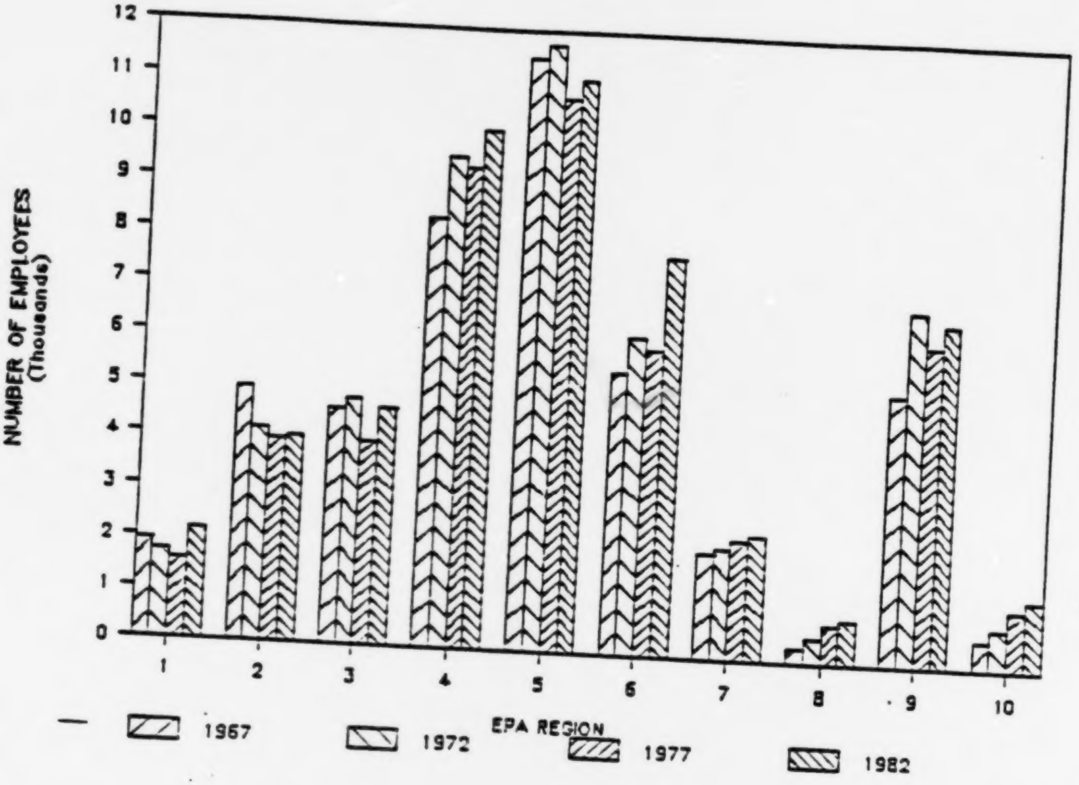
Again, these national data mask considerable regional variation. Employment remained nearly stagnant or contracted in the Northeast, Mid-Atlantic states, and Midwest (EPA Regions 1, 2, 3, and 5) (Figure 9-13). Most employment growth in the industry occurred in EPA Region 4 (where growth occurred throughout the region), Region 6 (particularly in Texas and New Mexico), and Region 9 (particularly in California).

9.5 Revenues Per Employee

Revenues per employee may serve as a very crude indicator of the efficiency of production in the industry; better indices of productivity are pounds processed per operator-hour or garments processed per operator-hour (28). Revenues per employee are the only data readily available on productivity in this industry, however, and provide some insight into industry characteristics and trends.

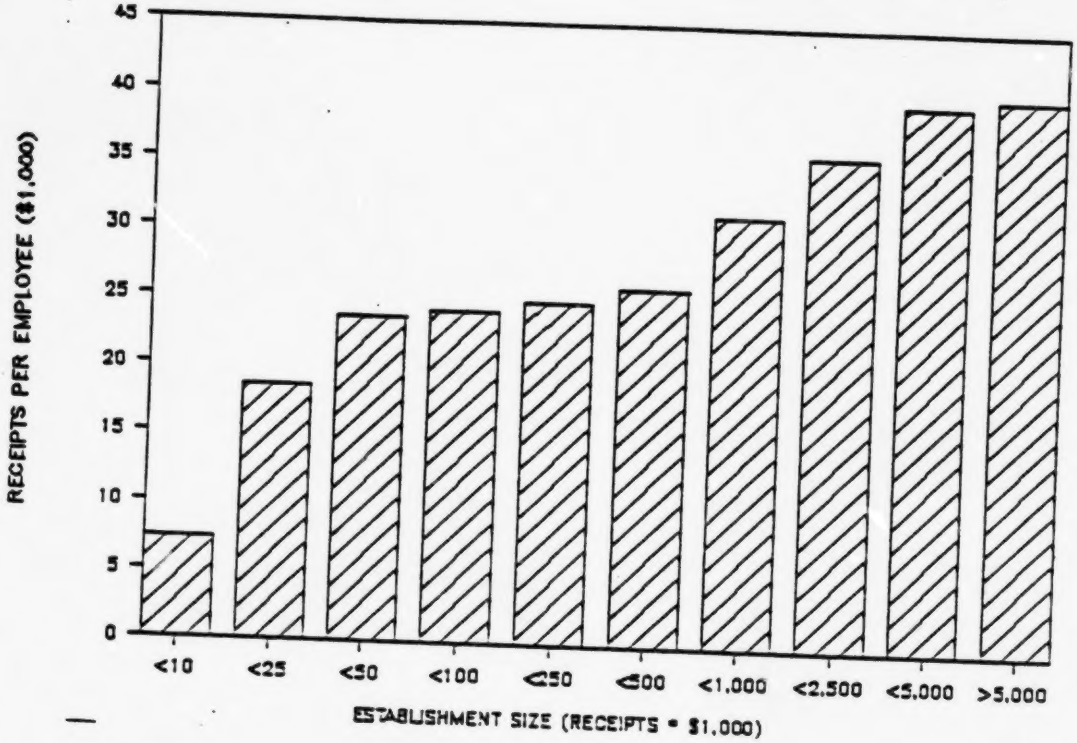
Figures 9-14 and 9-15 plot revenues per employee against establishment size. A clear trend toward increasing revenues per employee with increasing establishment revenues emerges from the data (Figure 9-14). No such trend is apparent when firm size is plotted as number of employees (Figure 9-15). One inference which may be drawn from these results is that those large establishments responsible for the trend discernible in Figure 9-14 are achieving significant revenue gains without adding large number of staff (i.e., that significant productivity gains can be achieved within this industry) but that many large establishments (in terms of employment) have opted not to invest, or do not have the resources to invest in productivity-increasing expenditures.

9.5.1 Trends. Both nationally and in individual regions, there is no clear trend in these data (Figure 9-16); certainly there has been no increase in revenues per employee. This result may be related either to the fact that no productivity increases have been achieved in the industry, or that productivity increases have been entirely consumed by cost competition. Given the evidence that there has been a continual addition of new entrants into this essentially stagnant industry, the latter interpretation appears likely to be correct.



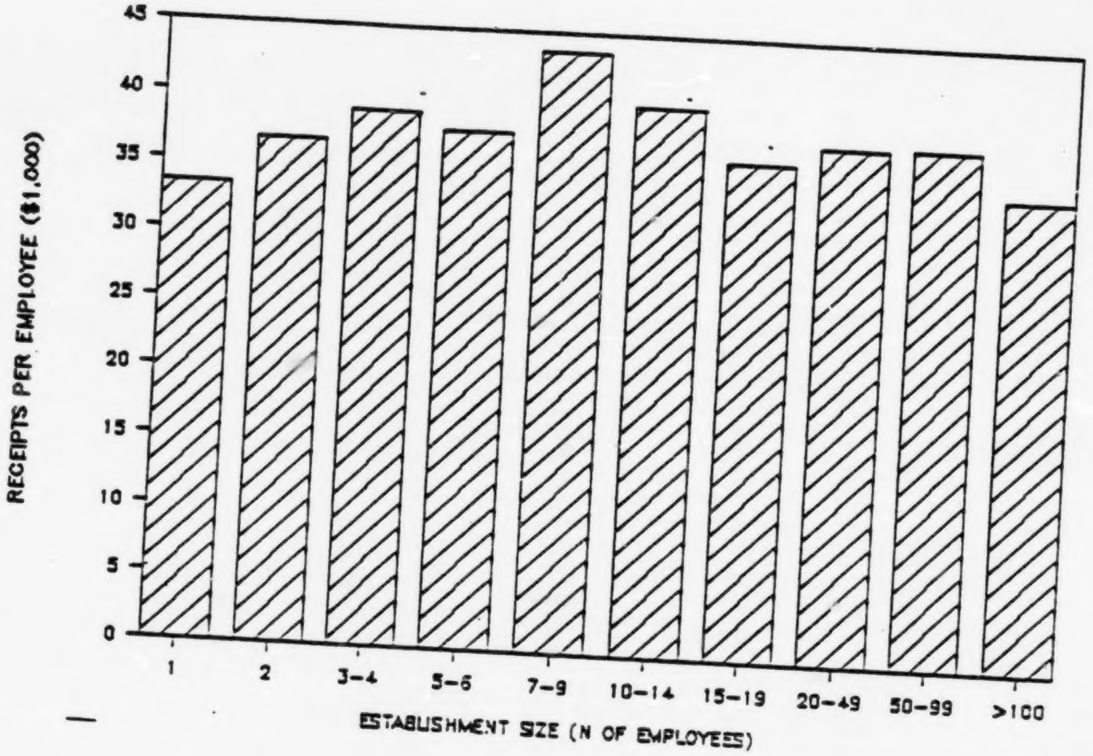
Source: Industrial Laundry Industry and its Markets (29), based on U.S. Census Bureau, Census of Service Industries

Figure 9-13 Industrial laundry employment, 1967-1982.



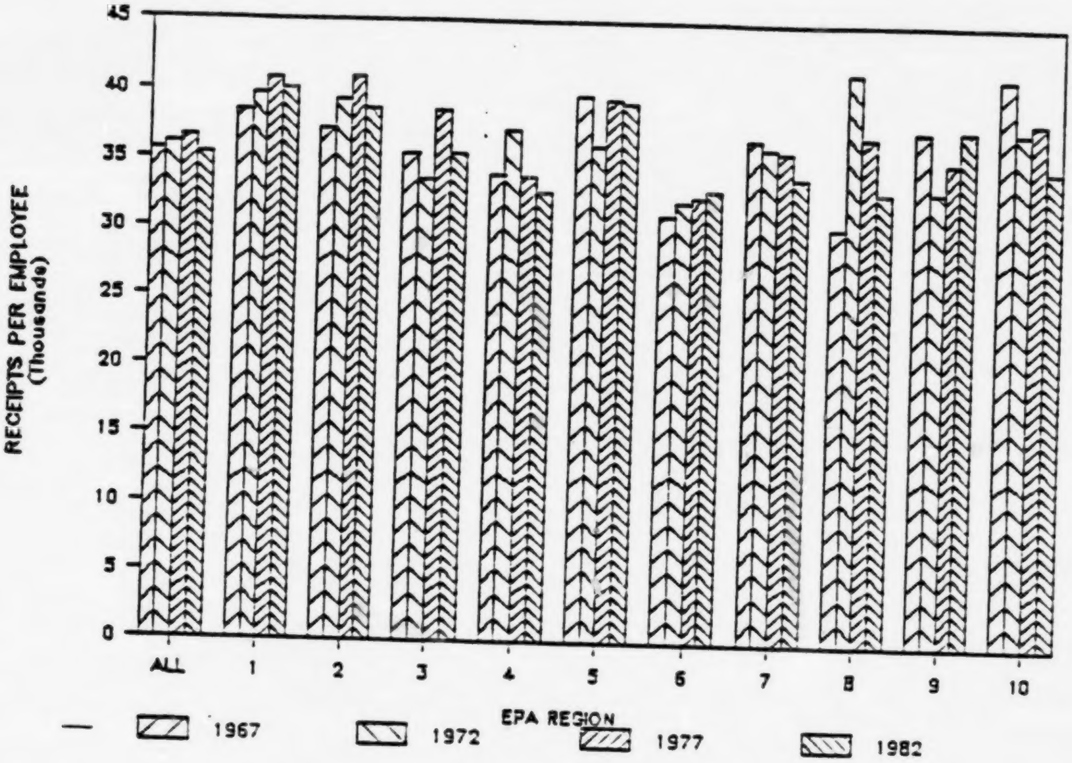
Source: U.S. Census Bureau 1982

Figure 9-14 Industrial laundry revenues per employee, by establishment size (revenues), 1982.



Source: U.S. Census Bureau 1982

Figure 9-15 Industrial laundry revenues per employee, by establishment size (n of employees), 1982.



Source: Industrial Laundry Industry and its Markets (29), based on U.S. Census Bureau, Census of Service Industries

Figure 9-16 Industrial laundry revenues per employee (constant dollars), 1967-1982.

SECTION 10

10.0 ECONOMIC INFLUENCES ON THE INDUSTRIAL LAUNDRY INDUSTRY

Major influences on the industrial laundries industry are competition, availability of substitute goods and services, and environmental regulation. These are discussed in this section.

10.1 Competition

The industry has witnessed some growth in the number of establishments competing for a market which has itself exhibited little growth. The clear implication is that there must exist increasing competition for a stable customer base.

The industry's traditional primary markets, garments and shop towels, have not grown significantly in the past 20 years. In the garment market segment, contraction of the market among heavy soil industrial establishments has been offset by the growth of the market among light soil commercial and light industrial environments, but the net effect has been essentially a flat market. The shop towel market has exhibited no clear trend in recent years; certainly this market segment has not been growing. The only market segment which is experiencing significant growth is that for floor mats, which now account for over 10 percent of industrial laundry revenues (28).

Regionally, competition has been and remains intense in the Northeast and Midwest, where industrial laundry firms are competing for shrinking markets in their traditional heavy soil markets. Only California and Texas have witnessed significant revenue growth since 1967 (and one may assume that the Texas market has stabilized or contracted with the collapse of the oil industry there since 1982).

The industry has responded to increased competition mainly through price-cutting. Price cuts have apparently been achieved at the expense of profits and quality, since there is little evidence that productivity has increased significantly (28).

10.2 Availability of Substitute Goods and Services

Although some industrial laundry clients have moved toward ownership and in-house cleaning of the traditional industry laundry rental products, it does not appear that this trend poses a significant threat to the industry. Industrial laundries provide a service unrelated to their clients' own lines of business. They employ equipment and provide services much more efficiently than their clients could hope to if they did their own laundering in-house (28).

The one market segment in which substitute goods may replace industrial laundry goods and services is the shop towel market. Disposable, non-woven alternatives are currently available. The industry trade association has expressed concern that the availability of alternatives, coupled with fear of liability for environmental damage or potential environmental regulation of this heavy soil market segment, or both, may diminish the size of this market (28).

10.3 Environmental Regulation

Environmental regulation has already had a significant impact on this industry, since it has resulted in the virtual elimination of dry cleaning as an industrial laundering process. It appears unlikely that environmental regulation would pose a serious threat to the industrial laundry garment market, since there is no apparent replacement for work uniforms in heavy soil environments, and since much of the industrial laundry garment volume now comes from light soil environments from which heavily contaminated wastewaters are not a concern. One can envision scenarios, however, in which environmental regulation of launderers (resulting in higher prices), might cause some large customers with wastewater pretreatment systems already installed to move toward in-house laundering of soiled garments.

As noted above, environmental regulation is of concern to the industry in that it may reinforce a movement to develop cost-effective, disposable substitutes for laundered shop towels in heavy soil environments.

SECTION 11

11.0 FINANCIAL CHARACTERISTICS OF INDUSTRIAL LAUNDRIES AND ECONOMIC IMPACTS OF PRETREATMENT SYSTEM INSTALLATION AND OPERATION

This section describes the financial characteristics of industrial laundry firms and presents the estimated impact on firm profits of a requirement for ultrafiltration as a wastewater pretreatment system. Section 11.1 presents data on financial characteristics; Section 11.2 presents an analysis of the economic impacts of pretreatment system installation and operation on firm profits for three model industrial laundry plant sizes.

11.1 Financial Characteristics of the Industrial Laundries Industry

Several primary and secondary sources were consulted to locate data on the financial characteristics of this industry. Because of the industry's small size, it is omitted from most public compilations of industrial financial data (e.g., Internal Revenue Service data on industry income and profits). Private data sources (e.g., Robert Morris Associates 1987 [31], Dun and Bradstreet 1987 [32], Troy 1987 [33]) provide, at best, only summary data on the financial characteristics of firms in this industry.

For a 1981 analysis of the financial characteristics of the industry, EPA solicited and received industry financial data from the Institute of Industrial Laundries (IIL), the industry trade association. The IIL supplied summary financial data gathered from the voluntary submissions of over 100 industrial laundry firms. For the current analysis, IIL was asked to estimate the level of effort required to duplicate the data set provided for the 1981 EPA analysis. Based on their response, IIL was not asked to provide the same type of detailed industry data for this preliminary analysis that was compiled for the 1981 EPA analysis (34).

The financial data on which the current analysis is based are derived from Dun and Bradstreet's Industry Norms and Key Business Ratios(32). These data are based on a sample of 88 firms out of the approximately 800 in the entire industry. Dun and Bradstreet provide no information to indicate whether these firms are representative of the entire industry; based on sales volume, however, the mean firm size in the D&B sample is very nearly that estimated using Department of Commerce data on industry revenues (26, 1985, 1986). The D&B data provide a balance sheet and summary income statement which reflect the mean of all industrial laundry firms in D&B's database, as well as selected business ratios (liabilities:net worth, assets:sales, etc.).

Table 11-1 presents a summary balance sheet and income statement for the 88 firms in the D&B database. Table 11-2 presents 10 key business ratios for these firms; it presents the ratios

TABLE 11-1

CONSOLIDATED BALANCE SHEET AND INCOME STATEMENT FOR 88 INDUSTRIAL LAUNDRY FIRMS

	Dollars	Percent of Category
	Balance Sheet	
Assets		
Cash	63,927	8.7
Accounts Receivable	140,346	19.1
Notes Receivable	5,878	0.8
Inventory	96,993	13.2
Other Current Assets	56,579	7.7
Total Current	363,723	49.5
Fixed Assets	124,915	17.0
Other Long-Term Assets	246,156	33.5
TOTAL ASSETS	734,794	100.0
Liabilities and Net Worth		
Accounts Payable	60,988	8.3
Bank Loans	8,083	1.1
Notes Payable	28,657	3.9
Other Current Liabilities	106,545	14.5
Total Current Liabilities	204,273	27.8
Long Term Liabilities	132,263	18.0
Deferred Credits	1,470	0.2
Net Worth	396,789	54.0
Liabilities Plus Net Worth	734,795	100.0

	Condensed Income Statement	
	Dollars	Percent of Sales
Net Sales	1,400,000	100.0
Gross Profit	665,000	47.5
Net Profit After Tax	78,400	5.6

Source: Dun & Bradstreet 1987

TABLE 11-2

SELECTED FINANCIAL RATIOS FOR 88 INDUSTRIAL LAUNDRY FIRMS

Ratio	Upper Quartile %	Median %	Lower Quartile %
Quick Ratio [1]	1.7	1.1	0.7
Current Ratio [2]	3.5	1.9	1.2
Current Liabilities / Net Worth	15.6	35.8	77.0
Total Liabilities / Net Worth	21.8	60.8	126.8
Assets / Sales	37.8	58.3	70.1
Sales / Net Working Capital	13.1	6.4	3.7
Accounts Payable / Sales	2.5	3.6	6.0
Return on Sales (After Tax)	9.2	4.6	1.2
Return on Assets (After Tax)	11.7	6.9	2.0
Return on Net Worth (After Tax)	29.7	16.1	4.5

Notes:

[1] Cash + Accounts Receivable / Current Liabilities
[2] Current Assest / Current Liabilities

Source: Dun & Bradstreet 1987

applicable to the median firm in the D&B database and to the firms at the upper and lower quartile of the D&B sample for each ratio. A review of the following business ratios provides insight into the financial condition of this industry.

11.1.1 Quick Ratio, Current Ratio. The quick ratio expresses the ratio of the most liquid current assets (cash and accounts receivable) to current liabilities; the current ratio expresses the ratio of all current assets (including notes receivable, inventories, and other current assets) to current liabilities. Both ratios provide an indication of a firm's ability to cover current liabilities with current cash and near-cash assets. The lower quartile quick ratio of 0.7, and lower quartile current ratio of 1.2 reflected in Table 11-2 indicate that many firms in this industry operate on very slim margins of current income over current liabilities. Although this is a characteristic of many firms in high-volume, quick-turnaround industries, the lower quartile values for industrial laundries are extremely low, and suggest that for a significant fraction of laundries any diminution of cash flow might pose a serious threat to the firm's ability to meet the demands of short-term creditors.

11.1.2 Current Liabilities to Net Worth, Total Liabilities to Net Worth. These ratios compare the resources extended to the firm by its creditors with the capital invested by the firm's owners. High ratios indicates that the firm is heavily reliant on loans or trade credit or both for continuing operations, and signal that additional credit may be difficult to obtain. There is a great disparity when comparing the ratios of the median firm in the industry (current liabilities/net worth equal 36 percent; total liabilities/net worth equal 61 percent) and the firm at the lower quartile (current liabilities/net worth equal 77 percent; total liabilities/net worth equal 127 percent). Again, the ratios for the firm at the lower quartile suggest that a significant proportion of firms in this industry are already heavily in debt to outside creditors, and that additional financing (e.g., to cover the cost of pollution control equipment) may be difficult to obtain.

11.1.3 Return on Sales. This ratio provides a basic measure of the rate of profit generation by the firm. Again, more revealing than the absolute value of these figures (which may vary widely from industry to industry) is the size of the spread between the median and the quartile firms in the industry. Twenty-five percent of all firms in the industry earn a profit after taxes of less than 1.2 percent; the spread between the median firm and the firm at the lower quartile is nearly four times. These data suggest that a large number of industrial laundry firms are characterized by very slim operating margins, and may be extremely sensitive to any economic or regulatory pressures that tend to reduce industry profits.

[D&B provide no information about whether the firms in their database are publicly- or privately-held. Privately-held firms may deliberately reduce taxable profits (e.g., through bonuses or profit-sharing plans) in order to reduce their corporate income tax liability. Thus, if the D&B data are based on a significant proportion of privately-held firms, reported profits may tend to understate profits actually achieved in the industry.]

11.1.4 Return on Assets. This is a key indicator of profitability, comparing annual profit with the size of the assets employed to generate that profit. Because they are based on accounting values for assets (which may be very different from market or replacement value), summary ratios provide only a very crude indicator of actual economic returns. Nonetheless, the very low return on assets not only of the lower quartile firm, but of the median firm in this industry, suggest that this industry provides a relatively low return on invested assets, and that economic or other forces that tend to reduce profits will generate significant pressure to remove assets from this industry (i.e., to cease laundry operations in favor of other investment opportunities).

11.2 Economic Impact of Installation of Ultrafiltration Pretreatment System

This section provides an estimate of the economic impact of installation and operation of a wastewater pretreatment system for three model industrial laundry firms representing three plant sizes. For this analysis, economic impacts have been defined as the impact on pretax profits (defined as return on sales), assuming that none of the cost of the pretreatment system can be passed on to customers in the form of higher prices.

Section 11.2.1 specifies the three model firm sizes defined for the economic impact analysis. Section 11.2.2 provides the capital and operating costs of ultrafiltration pretreatment systems for each of the three model industrial laundry firms. Section 11.2.3 calculates the impact on pretax profits of ultrafiltration system installation and operation for each model firm.

11.2.1 Selection of Model Plants and Profit Categories. Three model plants were selected based on the distribution of plant size (defined by annual revenues) presented in Figure 9-4. The three model plants selected for analysis generate revenues as follows:

- Plant A: $ 300,000 per year
- Plant B: $1,000,000 per year
- Plant C: $2,500,000 per year

Table 11-3 compares the three model plants to the distribution of all establishments in the industry. Based on total revenues, Plant A represents approximately the 25th percentile of all establishments, Plant B represents nearly the median establishment in the industry, and Plant C represents approximately the 80th percentile of all establishments.

TABLE 11-3

DISTRIBUTION OF INDUSTRIAL LAUNDRY ESTABLISHMENTS BY ANNUAL REVENUES, AND COMPARISON WITH MODEL PLANT SIZES

Revenues ($1,000)	Number	Percent	Cumulative Percent	
< $10	8	0.6	0.6	
$10 - $25	15	1.2	1.8	
$25 - $50	31	2.5	4.3	
$50 - $100	50	4.0	8.3	Model Plant A: Revenues = $300,000/yr
$100 - $250	145	11.6	19.9	
$250 - $500	179	14.3	34.2	
$500 - $1,000	223	17.8	52.0	Model Plant B: Revenues = $1,000,000/yr
$1,000 - $2,500	350	27.9	79.9	Model Plant C: Revenues = $2,500,000/yr
$2,500 - $5,000	202	16.1	96.0	
> $5,000	50	4.0	100.0	
TOTAL	1,253	100.0		

Source: U.S. Department of Commerce 1985, 1986

This analysis is based on the assumption that the plant is the relevant unit for the estimation of economic impacts. D&B financial data (from which profitability estimates are derived) use the firm as the basic unit of analysis. To the extent that firms which operate more than one plant realize operating economies (e.g., reduction in overhead cost per unit of production), the D&B profitability estimates may tend to overstate the profits which may be obtained by a single-plant firm; the economic impacts on such single-plant firms may thus be greater than those estimated here.

Dun & Bradstreet provide after-tax return on sales for the median firm in the industry and for the firm at the lower and upper quartile in the D&B database. Eastern Research Group (ERG) made the assumption that the D&B quartile and median values apply to firms of all size classes in the industry. ERG estimated state and federal income taxes on the basis of gross revenues and after tax rate of profit; Table 11-4 specifies the tax rates applied to each model plant at the lower quartile, median, and upper quartile after tax profit rate specified in the D&B data. Using these values, ERG calculated before tax profits for each model plant at the lower quartile, median, and upper quartile profit rates; before tax profits approximate the annual cash flow in excess of operating costs (and therefore available to cover expenses related to installation and operation of effluent pretreatment systems, assuming that these expenses are not passed on to consumers through price increases).

For Plant A ($300,000 annual revenues), Figure 11-1 plots percent return on sales (before tax) against the dollar amount of these profits, and displays the percent and dollar profit rates for the lower quartile, median, and upper quartile firm in the industry; the upward sloping line equates percent profit (on the X-axis) to the corresponding dollar profit (Y-axis). Figure 11-2 plots these data for Plant B ($1,000,000 annual revenues), and Figure 11-3 plots the corresponding data for Plant C ($2,500,000 annual revenues). Given the percent pre-tax profit rate for an individual plant, the dollar volume of profits can be estimated by moving vertically to the sloping line, and then horizontally to the corresponding point on the Y-axis (e.g., in Figure 11-1, the median profit rate of 5.5 percent represents dollar profits of approximately $16,600/year).

11.2.2 Capital and Operating Costs of Ultrafiltration Pretreatment Systems. Ultrafiltration has been identified as the pretreatment technology for which costs and economic impacts should be calculated. Capital and operating costs for ultrafiltration systems were estimated based on information supplied by two system vendors. The vendors were asked to provide cost estimates for systems applicable to each of the three plant sizes defined above.

Table 11-5 summarizes the calculation of pretreatment system size applicable to each model plant, and presents the annualized capital and operating cost of each ultrafiltration system. Calculation of system size depends first on the conversion of annual revenues into pounds of laundry processed per year; ERG employed a value of $0.80/pound to make this conversion. This value is the same as that used in EPA's 1981 Economic Analysis of Proposed Effluent Guidelines in this industry (34). ERG was unable to develop a summary cost estimate based on more recent information, primarily because the basic cost information was not readily available. IIL pointed out that there exists significant pricing variation geographically between regions, temporally within individual regions or markets, and even between individual accounts held by a single launderer (30). ERG based its decision to retain the 1981 estimate of $0.80/pound on its assessment of the economic and competitive forces which have affected this industry since the 1981 EPA estimate was made. A second calculation generates an estimate of total annual effluent production on the basis of wastewater generation per pound of laundry processed; ERG employed a value of 4.3 gallons effluent/pound laundry on the basis of information presented in the technology section of this document. A final conversion from gallons per year to gallons per day (the common sizing unit for pretreatment systems) was based upon an estimate of 260 days of system operation per year.

Based on these calculations, system suppliers provided estimates of the capital and operating costs of ultrafiltration pretreatment systems of the following three size classes.

- Plant A: 6,000 Gallons Per Day (GPD)
- Plant B: 20,000 GPD
- Plant C: 50-55,000 GPD

Table 11-5 presents the capital and operating system costs provided by the ultrafiltration system vendors for each of the three hypothesized pretreatment systems. Capital cost estimates represent the lump sum payment for a turnkey system, installed and ready for operation. To translate this single payment into an annual cost, the capital cost was amortized over 15 years using a 10 percent discount rate. Table 11-4 presents this calculation, and presents the annualized capital and operating cost of installation and operation of each system.

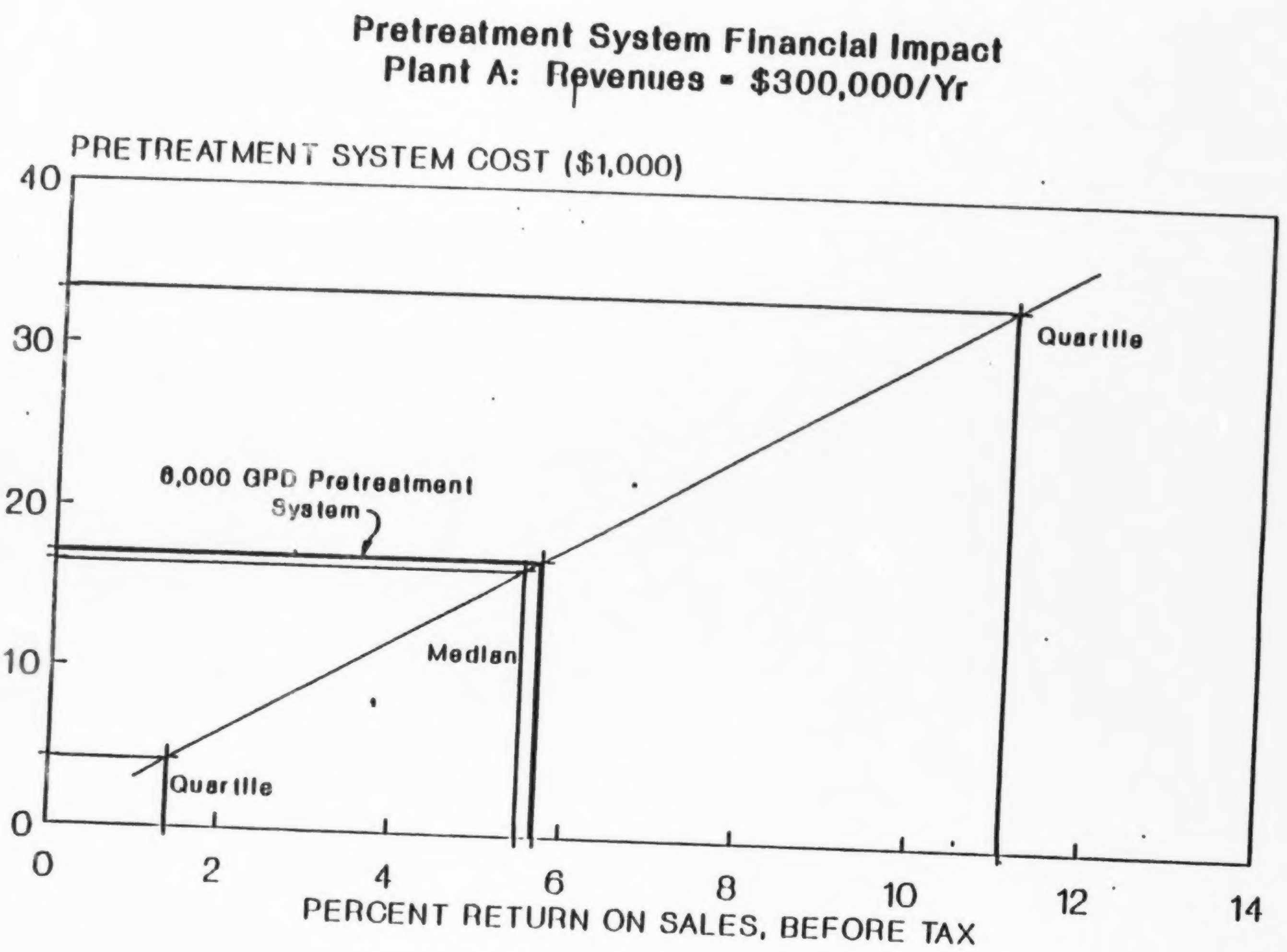


Figure 11-1 Analysis of pretreatment system financial impact: Model Plant A (Revenues = $300,000/Year). Median pre-tax profit rate = 5.5%.

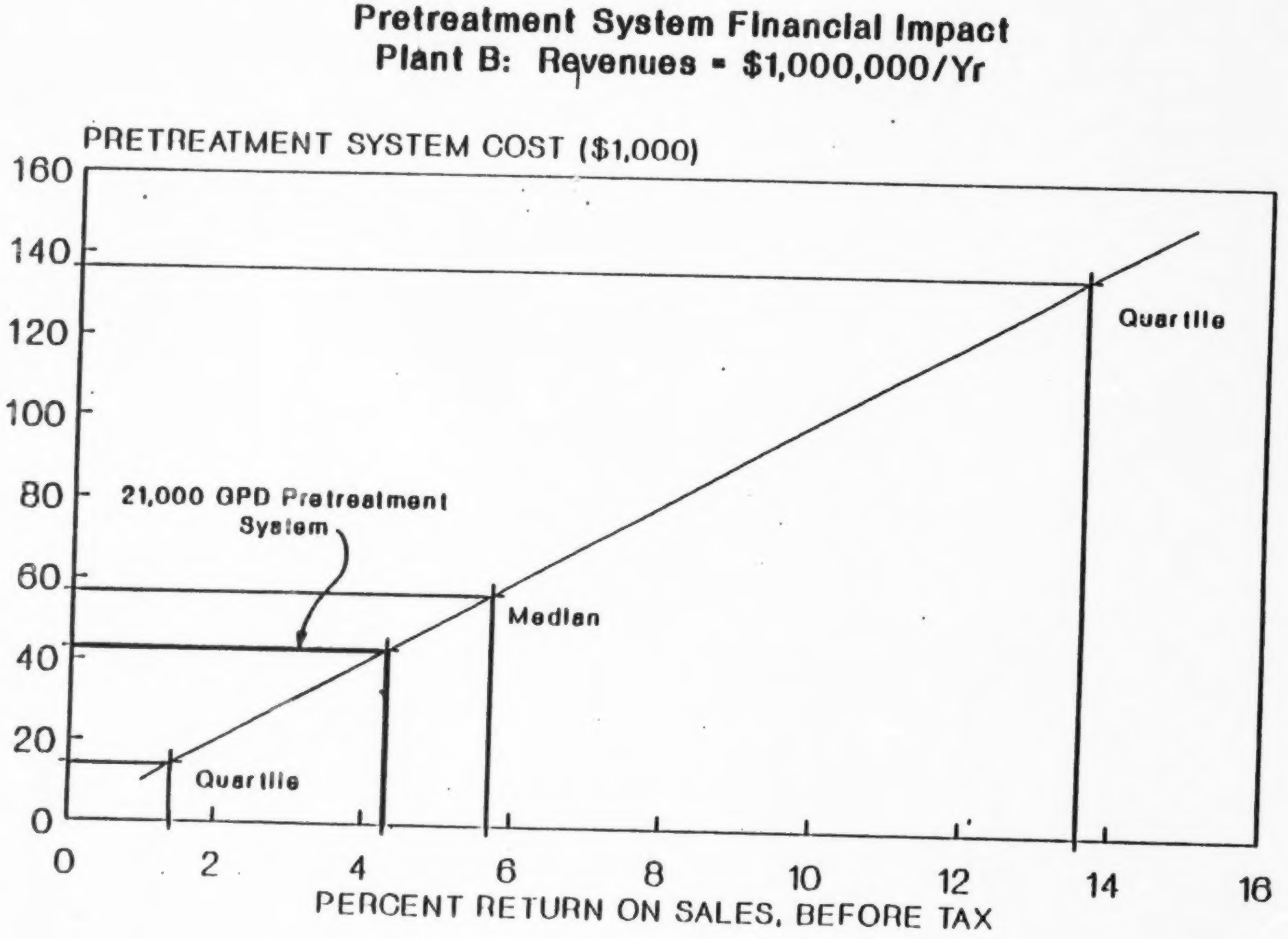


Figure 11-2 Analysis of pretreatment system financial impact: Model Plant B (Revenues = $1,000,000/Year). Median pre-tax profit rate = 5.7%.

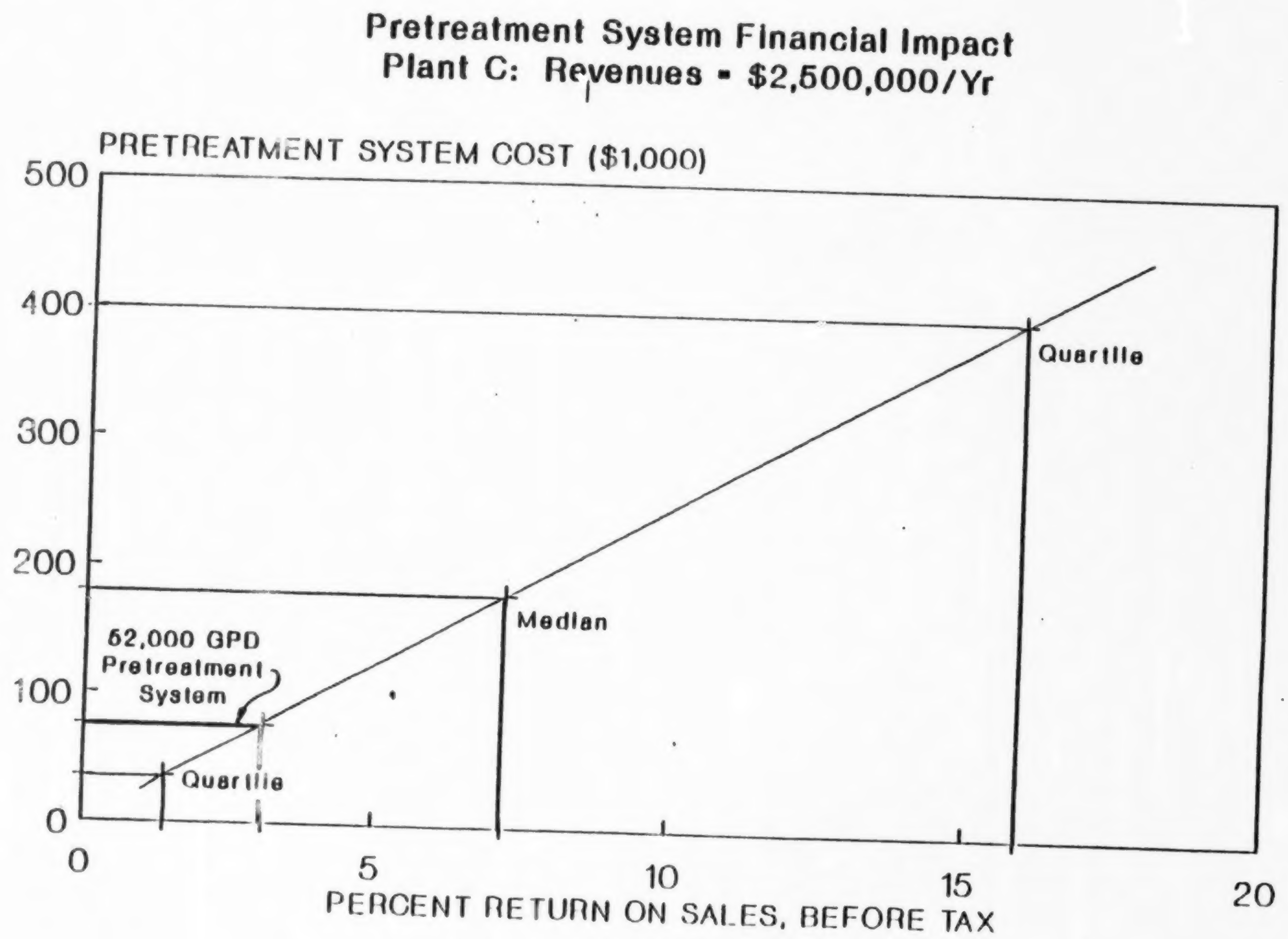


Figure II-3 Analysis of pretreatment system financial impact: Model Plant C (Revenues = $2,500,000/Year). Median pre-tax profit rate = 7.2%.

TABLE 11-4

STATE AND FEDERAL INCOME TAXES APPLIED TO INDUSTRIAL LAUNDRIES OF THREE SIZE AND PROFIT CLASSES

	After Tax Profit		
	Lower Quartile 1.2%	Median 4.6%	Upper Quartile 9.2%
MODEL PLANT A: REVENUES = $300,000/yr			
Revenues	$300,000	$300,000	$300,000
After Tax Profits	3,600	13,800	27,600
State Income Tax	100	400	830
Federal Income Tax	600	2,400	4,900
Before Tax Profits	4,300	16,600	33,330
Before Tax Profit Rate	1.4%	5.5%	11.1%
Overall Tax Rate	16%	17%	17%
MODEL PLANT B: REVENUES = $1,000,000/yr			
Revenues	1,000,000	1,000,000	1,000,000
After Tax Profits	12,000	46,000	92,000
State Income Tax	350	1,500	3,400
Federal Income Tax	2,100	9,500	41,000
Before Tax Profits	14,450	57,000	136,400
Before Tax Profit Rate	1.4%	5.7%	13.6%
Overall Tax Rate	17%	19%	33%
MODEL PLANT C: REVENUES = $2,500,000/yr			
Revenues	2,500,000	2,500,000	2,500,000
After Tax Profits	30,000	115,000	230,000
State Income Tax	900	4,500	10,000
Federal Income Tax	5,300	60,500	158,500
Before Tax Profits	36,200	180,000	398,500
Before Tax Profit Rate	1.4%	7.2%	15.9%
Overall Tax Rate	17%	36%	42%

Source: Revenue and after tax profits from Dun & Bradstreet 1987. Tax calculation based on U.S. Tax Guide 1988, published by Commerce Clearing House, Inc.

TABLE 11-5

ANNUAL EFFLUENT PRODUCTION AND PRETREATMENT SYSTEM COSTS FOR THREE MODEL INDUSTRIAL LAUNDRY PLANTS

MODEL PLANT A / ANNUAL REVENUES = $300,000		
PLANT CHARACTERISTICS		
Annual Revenue	300,000	$/year
Price ($/lb)	0.80	$/lb
Annual lbs Processed	375,000	lb/year
Weekly lbs Processed	7,212	lb/week
Effluent (gal/lb)	4.3	gal/lb
Weekly Effluent	31,010	gal/week
Daily Effluent	6,202	gal/day
TREATMENT SYSTEM COSTS		
System Cost (Includes Installation/Startup)	$100,000	
Amortization Factor	7.606	
Annual Capital Cost	$13,148	per year
Operating Cost/Gallon	0.25	cents/gal
Gallons/Year	1,612,500	gal/year
Operating Cost/Year	$4,031	per year
TOTAL COST/YEAR	$17,179	per year

Source: See text for discussion of laundering price. Calculation of wastewater volume based on data presented in Section 5.1 of this document. Treatment system costs based on information supplied by system vendors.

TABLE 11-5 (Continued)

ANNUAL EFFLUENT PRODUCTION AND PRETREATMENT SYSTEM COSTS FOR THREE MODEL INDUSTRIAL LAUNDRY PLANTS

MODEL PLANT B / ANNUAL REVENUES = $1,000,000		
PLANT CHARACTERISTICS		
Annual Revenue	1,000,000	$/year
Price ($/lb)	0.80	$/lb
Annual lbs Processed	1,250,000	lb/year
Weekly lbs Processed	24,038	lb/week
Effluent (gal/lb)	4.3	gal/lb
Weekly Effluent	103,365	gal/week
Daily Effluent	20,673	gal/day
TREATMENT SYSTEM COSTS		
System Cost (Includes Installation/Startup)	$225,000	
Amortization Factor	7.606	
Annual Capital Cost	$29,582	per year
Operating Cost/Gallon	0.25	Cents/gal
Gallons/Year	5,375,000	gal/year
Operating Cost/Year	$13,438	per year
TOTAL COST/YEAR	$43,019	per year

Source: See text for discussion of laundering price. Calculation of wastewater volume based on data presented in Section 5.1 of this document. Treatment system costs based on information supplied by system vendors.

TABLE 11-5 (Continued)

ANNUAL EFFLUENT PRODUCTION AND PRETREATMENT SYSTEM COSTS FOR THREE MODEL INDUSTRIAL LAUNDRY PLANTS

MODEL PLANT C / ANNUAL REVENUES = $2,500,000		
PLANT CHARACTERISTICS		
Annual Revenue	2,500,000	$/year
Price ($/lb)	0.80	$/lb
Annual lbs Processed	3,125,000	lb/year
Weekly lbs Processed	60,096	lb/week
Effluent (gal/lb)	4.3	gal/lb
Weekly Effluent	258,413	gal/week
Daily Effluent	51,683	gal/day
TREATMENT SYSTEM COSTS		
System Cost (Includes Installation/Startup)	$325,000	
Amortization Factor	7.606	
Annual Capital Cost	$42,729	per year
Operating Cost/Gallon	0.25	cents/gal
Gallons/Year	13,437,500	gal/year
Operating Cost/Year	$33,594	per year
TOTAL COST/YEAR	$76,323	per year

Source: See text for discussion of laundering price. Calculation of wastewater volume based on data presented in Section 5.1 of this document. Treatment system costs based on information supplied by system vendors.

11.2.3 Economic Impacts of Ultrafiltration Pretreatment Systems. Three indicators are frequently developed to estimate the impact of increased costs on an industry:

- Impact on profits assuming that costs cannot be passed on to customers in the form of higher prices.
- Impact on prices if current profit margins or dollar profit volumes are to be maintained.
- Impact on the industry's ability to attract capital to finance the required investment.

For the current analysis, only the first indicator, impact on profits assuming no cost pass-through, has been estimated. Calculation of the second indicator, impact on prices to maintain current profits, requires data on the cost structure of the industry (specifically, data defining the relationship between fixed and variable costs) which are not contained in the data sources available for this analysis. Calculation of the third indicator, ability to attract capital, hinges on a more exact specification of model plant financial condition than has been attempted here.

Impact on Model Plant A (Annual Revenues = $300,000) - Figure 11-1 plots the annual cost of an approximately 6,000 Gallon Per Day (GPD) ultrafiltration pretreatment system against the distribution of pre-tax profits (return on sales) for a firm in this size class. The annualized cost of the pretreatment system (approximately $17,200/year) corresponds to a pre-tax rate of profit of approximately 5.7 percent. This is greater than the pre-tax profit of the median firm for this plant size. Over 50 percent of all firms of this size, therefore, could not maintain a positive rate of profit if they were required to install this pretreatment system (assuming that pretreatment costs are not passed on to consumers in the form of higher prices).

Impact on Model Plant B (Annual Revenues = $1,000,000) - Figure 11-2 plots annualized pretreatment system costs against the distribution of pre-tax profits (return on sales) for a model plant with annual revenues of $1,000,000. The estimated annualized cost of the pretreatment system ($43,000/year) corresponds to a pre-tax profit rate of 4.3 percent. This is approximately 2.5 times the profits earned by the lower quartile firm in the industry, and indicates that significantly more than 25 percent of all firms of this size could not maintain a positive rate of profit if required to install and operate the hypothesized ultrafiltration system.

Impact on Model Plant C (Annual Revenues = $2,500,000) - Figure 11-3 compares annualized pretreatment system costs for an approximately 52,000 GPD pretreatment system against the distribution of pre-tax profits (return on sales) for Model Plant C. The annualized cost of this pretreatment system is approximately $76,000/year, and corresponds to a pre-tax rate of profit of 3.0 percent. Again, this value is significantly greater than the rate of profit earned by the lower quartile firm in the industry; that is, over one fourth of all firms represented by this model plant would have negative earnings if required to install and operate this pretreatment system.

11.3 Summary of Economic Impacts

Under the assumption that costs cannot be passed through to customers in the form of higher prices, this analysis has indicated that installation and operation of an ultrafiltration pretreatment system may result in severe economic impacts for a large proportion of firms in the industrial laundry industry. For all three model plants analyzed, the annualized cost of pretreatment system operation is greater than the pre-tax rate of profit earned by over one-fourth of all firms in the industry. Calculated impacts are much greater for smaller firms in the industry. Annual pretreatment costs are greater than the estimated pre-tax profits earned by over one-half of all firms of this size, and (as Table 11-6 demonstrates) a smaller firm would require a much higher rate of profit to cover pretreatment costs than would a larger firm.

Given the distribution of firm sizes reflected in Table 11-3, one can infer that the profits of a large proportion of all firms in the industry could be severely impacted if this pretreatment technology is required (assuming no cost pass through). One can also infer that the magnitude of the impact may be inversely proportional to firm size, and therefore that the competitive position of smaller firms vis-a-vis larger firms in the industry would be eroded. This situation would hasten a trend toward consolidation which is already apparent in the industry.

The majority of revenues and employment in the industry are currently generated by the largest firms (see Figure 9-9 and Section 9.3). Thus, although the profitability and perhaps the viability of many small firms may be threatened by a potential requirement for an ultrafiltration pretreatment system, the majority of the industry workforce is employed by firms less jeopardized by this requirement.

With the data in hand, it is difficult to predict the potential impact of a pretreatment system requirement on such variables as the cost of industrial laundry services or industry competitiveness. A significant unknown is the proportion of privately-held firms in the industry and the extent to which their reported profits may understate their true financial health; the impacts calculated here will be mitigated if this is true for significant numbers of firms. It is virtually certain that prices would rise as industrial laundries pass along their higher costs to consumers. It is also apparent that larger firms would be likely to require a smaller price increase to meet profit targets than would smaller firms; again, this fact should tend to increase the dominance of larger firms in the industry, as smaller firms either leave the industry or are absorbed by the larger firms.

The preceding argument also suggests that a pretreatment system requirement may ultimately tend to reduce competitiveness in the industry. If smaller firms are in fact driven from the industry, each geographic market may come to be dominated by one or a very few large firms.

TABLE 11-6

ANNUALIZED COST OF PRETREATMENT SYSTEM EXPRESSED AS PERCENT OF REVENUES FOR THREE INDUSTRIAL LAUNDRY MODEL PLANTS

	Annual Revenues	Annualized Cost of Pretreatment System	Pretreatment Cost as Percent of Revenues
Model Plant A	$300,000	$17,179	5.7%
Model Plant B	$1,000,000	$43,019	4.3%
Model Plant C	$2,500,000	$76,323	3.1%

Note: Annualized costs based on 15-year equipment life and discount rate of 10%

Source: Calculations presented in Table 11-5

ENVIRONMENTAL IMPACT ANALYSIS

SECTION 12

12.0 ENVIRONMENTAL IMPACT ANALYSIS

A study is presented in this section of the impact of the wastewater discharge from the industrial laundries industry on the publicly owned treatment works (POTWs) and the streams to which the POTWs subsequently discharge.

12.1 Summary of the Environmental Impact Study

This study evaluates the impacts of fourteen indirect discharging industrial laundry plants on receiving streams and on publicly owned treatment works (POTWs).

Receiving stream impacts are evaluated by comparing estimated instream pollutant concentrations with aquatic life toxic effects levels and EPA Water Quality Criteria developed for human health and aquatic life protection. Two sets of data are used to estimate instream concentrations: 1) effluent monitoring pollutant concentrations and plant flows from five indirect laundries along with the (actual receiving) POTW flows, and low receiving stream flows (7-Q-10); and 2) effluent monitoring pollutant concentrations and plant flows from nine indirect discharging laundries with two representative POTW and two representative receiving stream flow conditions (the 25th and 50th percentile of indirect laundry POTWs and receiving streams). The 25th percentile analysis means that 75 percent of the POTWs with indirect laundries and 75 percent of their receiving streams have flows greater than the flow used in the model.

Impacts on POTWs are evaluated in terms of inhibition of POTW operations and contamination of POTW sludges. Inhibition problems are estimated by comparing calculated POTW influent pollutant concentrations with POTW inhibition levels. Sludge contamination problems are estimated by comparing calculated sludge pollutant concentrations with phytotoxic sludge contamination levels; human health criteria are applied to the cadmium and lead levels, while phytotoxic criteria are used for the five other pollutants.

The first set of sampling data from five indirect laundry plants reveals that these plants discharge from 32 pollutants (Plant F) to 56 pollutants (Plants A and B). A total of 86 pollutants are evaluated; 47 are priority pollutants. Inhibition and sludge contamination levels are available for only a limited number of priority pollutants. Therefore, only 14 and 7 pollutants are evaluated for potential inhibition and sludge contamination problems, respectively.

The second set of sampling data from nine plants reveals that these indirect dischargers discharge from 7 (Plant 6) to 30 pollutants (Plant 1). A total of 51 pollutants are evaluated: 47 are priority pollutants. Eighteen priority pollutants are evaluated for potential inhibition problems, as well as seven for sludge contamination.

The first data set analysis projects minimal water quality impacts. Two pollutants, benzidine and arsenic, exceed the human health criteria by magnitudes of only 10 and 1, respectively (Table 12-1). Benzidine and arsenic are known carcinogens. Although benzidine is not generally persistent, it has a half-life in water of six hours. Only one pollutant, cyanide, exceeds the chronic aquatic life criteria by a magnitude of one. Cyanide is not persistent in surface water; it has a half-life of between 10 to 50 hours in natural waters. No pollutants exceed the acute aquatic life criteria.

The second set of data analyzed projects water quality impacts. Two pollutants, arsenic and lead, exceed both the human health and chronic aquatic life criteria at the 50th percentile flow (Table 12-2). At the 25th percentile, six pollutants exceed criteria. Four pollutants, bis(2-ethylhexyl)phthalate, arsenic, methylene chloride, and carbon tetrachloride exceed human health criteria. All of these pollutants are known or suspected carcinogens. These pollutants are solvents introduced from the laundering of shop towels. Two pollutants, lead and bis(2-ethylhexyl)phthalate, exceed chronic aquatic life criteria. No pollutants exceed the acute aquatic life criteria.

Two pollutants, zinc and lead, exceed POTW inhibition levels. No pollutants exceed the sludge contamination levels.

Major findings based on available discharge monitoring data indicate minimal impacts on water quality and on POTWs, except for solvents such as benzidine. Benzidine is an example of a solvent found in the laundering of shop towels (rags used in paint spray booths and automotive repair shops). In this industry, there is no product control regarding the type of solvents in the soiled material to be laundered. Therefore, the potential for other solvents similar to benzidine to enter into the laundry water discharge is present.

12.2 Methodology

A POTW model was used to predict the potential environmental impacts associated with the raw indirect discharge of industrial laundries' wastewaters into POTWs and, ultimately, into receiving streams. The potential environmental impacts evaluated through the use of the POTW model include: (1) inhibition of POTW processes (determined by comparing calculated influent pollutant levels with available inhibition criteria or levels; (2) contamination of POTW sludge and thereby limiting its use (determined through comparison of expected pollutant concentrations in POTW sludge with sludge contamination criteria); and (3) effect on surface water into which the POTW discharges (determined through comparison of calculated POTW effluent concentrations with acute water quality criteria for aquatic life, and calculated instream concentrations under low stream flow [7-Q-10] conditions with chronic aquatic life and human health water quality criteria, and drinking water standards).

TABLE 12-1

SUMMARY OF WATER QUALITY CRITERIA EXCEEDANCES
RCRA/ITD SAMPLING DATA

Plant Number	Pollutant	Criteria Exceedances* At Actual POTW Flow And Low Receiving Stream Flow
A & B		No Exceedances
C	Arsenic	H(7.2)
	Cyanide	C(2.2)
D	Benzidine	H(640)
	Arsenic	H(2.9)
E		No Exceedances

*Criteria exceedances denoted by:

Type of Criteria (Concentration/Criteria)
Types of Criteria: H - Human Health-Ingesting water and organisms
C - Aquatic Life-Chronic

TABLE 12-2

SUMMARY OF WATER QUALITY CRITERIA EXCEEDANCES
1978 SAMPLING DATA

Plant Number	Pollutant	Criteria Exceedances* 50th Percentile (POTW & Rec. Stream)	25th Percentile (POTW & Rec. Stream)
1	Bis(2-ethylhexyl)phthalate	--	H(1.3)
	Arsenic	H(3.2)	H(21.7)
	Lead	--	C(3.5)
	Zinc	--	I(1.8)
2	Methylene Chloride	--	H(1.1)
	Arsenic	H(3.8)	H(26.0)
	Lead	C(1.0)	I(1.4)/C(6.9)
	Zinc	--	I(2.2)
3	Arsenic	H(4.1)	H([illegible]2)
	Lead	--	C(3.2)
	Zinc	--	I(1.3)
4	Lead	--	C(4.0)
	Zinc	--	I(1.3)
5	Arsenic	H(3.5)	H(23.8)
	Lead	--	C(2.2)
6	Lead	--	C(4.0)
	Zinc	--	I(1.4)
7	Carbon Tetrachloride	--	H(3.0)
	Arsenic	H(1.4)	H(9.7)
8	Bis(2-ethylhexyl)phthalate	--	C(3.2)/H(5.5)
	Arsenic	H(4.0)	H(27.1)
	Lead	--	C(3.3)
	Zinc	--	I(1.6)
9	Lead	--	I(1.2)/C(5.8)
	Zinc	--	I(1.6)

*Criteria exceedances denoted by:

Type of Criteria (Concentration/Criteria)
Type of Criteria: H - Human Health-Ingesting water and organisms
A - Aquatic Life-Acute
C - Aquatic Life-Chronic
I - POTW Inhibition

To determine potential environmental impacts of indirect dischargers, two approaches were used. The first approach used plant-specific information (i.e., actual plant, POTW, and receiving stream flows) for five laundries that were sampled under the ITD/RCRA program. The second approach was used when plant-specific data were not available. Plant-specific data were not available for data collected under a 1978 sampling program and, therefore, average plant flows and 50th (median) and 25th percentile POTW and receiving stream flows for the entire industry were used for each of these nine plants. These POTW/receiving stream flows were based on information provided by the Agency's IFD and GAGE files for indirect facilities with a SIC code of 7218. Plant flows and concentrations were obtained from Section V of this document. Average values were used when plants were sampled more than once.

The profile of the industrial laundries industry used in the environmental impact analysis is presented in Table 12-3. The profile is based on information in the Technical Support Section of this document.

The concentrations and criteria for each facility analyzed and for the receiving POTWs and model POTWs are presented in Appendices E through H.

12.3 Environmental Analysis Results and Conclusions

Impacts of the discharge from POTWs on their receiving streams were projected for human health and aquatic life. Impacts on POTWs were also projected. In addition, profiles of receiving streams and the environmental fate of the pollutants of concern are presented.

12.3.1 Impacts on Human Health

Seventeen of the 82 pollutants discharged by the ITD/RCRA facilities are known, suspected, or potential human carcinogens. Of the five ITD/RCRA facilities modeled, two caused instream exceedances of arsenic water quality criteria and one exceeded the criteria for benzidine. For the "1978" facilities: six of the nine exceeded the arsenic water quality criteria at both the 25th and 50th percentile flows; two plants exceed the water quality criteria for bis(2-ethylhexyl)phthalate (DEHP) at the 25th percentile only; one plant caused a slight exceedance (1.1 times the criteria) for methylene chloride at low flow; and one exceeded the water quality criteria for carbon tetrachloride at low flow.

12.3.2 Impacts on Aquatic Life.

The only exceedance of aquatic life water quality criteria for the ITD/RCRA facilities was for cyanide (exceedance factor of 2.2). The water quality criteria for lead was exceeded at eight of the nine "1978" facilities at the 25th percentile flows, but only one facility at average flows. Also, one exceedance of the water quality criteria for DEHP was projected at the 25th percentile.

TABLE 12-3

PROFILE OF INDUSTRIAL LAUNDRIES INDUSTRY USED IN THE ENVIRONMENTAL IMPACT ANALYSIS

Number of Facilities

Laundry or dry-cleaning facilities: 1,000

Type of Discharge

Indirect discharging facilities: 1,000

- Total Flow: 68 MGD
- Average Flow per Plant: 0.068 MGD
- Operating Days per Year: 260
- Frequency of Discharge: Variable

Raw Pollutant Loadings to Water

Priority Pollutant Loadings:

- Priority Pollutant Organics: The discharge of 13,770 lbs/day of priority pollutant organics is slightly less than the amount discharged by the Petroleum Refining Industry at the raw treatment level. It is also 13 times greater than the level discharged by the Organic Chemicals Industry at the PSES.

- Priority Pollutant Inorganics: These loadings are estimated at 7,130 lbs/day, roughly twice the amount discharged by the Leather Tanning and Finishing Industry at raw and slightly more than the Metal Finishing/Electroplating Industry at PSES.

Conventional Pollutant Loadings:

- TSS: Raw loadings of 590,400 lbs/day are six times greater than the Organic Chemicals current load and one-sixth the load discharged by all priority industries at PSES.

- BOD5: The total raw load of 635,173 lbs/day for industrial laundries is ten times greater than the Organic Chemicals current load and roughly twice the load discharged by the Leather Tanning Industry at PSES.

12.3.3 POTW Impacts

No POTW impacts (inhibition or sludge contamination) were projected for the ITD/RCRA facilities. The only impact projected for the "1978" facilities was for inhibition at the 25th percentile flows. Zinc exceeded inhibition criteria at seven of the nine facilities and lead exceeded at two facilities.

12.3.4 Receiving Stream Profiles

The following is a statistical breakdown of the flows for the industrial laundries, as obtained from EPA's IFD and GAGE files, together with a comparison of rivers with similar flow rates.

Percentile	Plant Flow	POTW Flow	Receiving Stream Average Flow	Receiving Stream 7-Q-10 Flow
25	0.048	4.600	176.664	4.103
50	0.094	12.300	662.218	47.016
75	0.175	44.900	2,750.263	527.021

The average flow in receiving stream at the 25th percentile is equivalent to the average flow in Bull Run at Clifton, Virginia.

The average flow in receiving stream at the 50th percentile is slightly greater than the Monocacy River at Frederick, Maryland.

The average flow in receiving stream at the 75th percentile is greater than that in the Rappahannock River at the mouth (1,100 MGD) and less than the James River at Richmond, Virginia (4,900 MGD).

12.3.5 Pollutant Fate

The environmental fates of pollutants of concern are presented in Table 12-4.

TABLE 12-4

ENVIRONMENTAL FATE OF POLLUTANTS OF CONCERN

Pollutant	Fate
Arsenic	Arsenic is very mobile in the aquatic environment and is constantly transported between the water, sediments, and biota. It is sorbed as an inorganic ion but biotransformation to methylated forms may release it to the water and atmosphere. It is not highly concentrated in the biota (BCF=44). Not persistent.
Benzidine	Sorption to sediments (especially clay) is the principal fate process. Oxidation by dissolved and precipitated metals cations, such as Fe^{+3}, Cu^{+2} will degrade benzidine in surface waters (half-life=6.0 hours). Not persistent.
Bis(2-ethylhexyl)phthalate	Strongly sorbed to organic material of surface water but it is not considered to be persistent in riverine systems. It is bioaccumulated but also biodegraded by most organisms. Transport downstream considered to be the principal fate.
Carbon tetrachloride (Tetrachloromethane)	Volatilization is the principal fate from surface water. The half-lives range from less than one hour to several hours, depending on the agitation of the water. Other fate processes are probably not important, but since volatilization is rapid, tetrachloromethane should not be persistent in surface water.

TABLE 12-4 (Continued)

ENVIRONMENTAL FATE OF POLLUTANTS OF CONCERN

Pollutant	Fate
Cyanide	Cyanide is not persistent in the environment. The half-life for volatilization ranges from 0.5 to 50 hours, depending on pH. Cyanide is also metabolized by all aquatic organisms. Field studies have demonstrated that cyanide is not persistent in surface waters.
Lead	Lead is persistent in the sediments of surface water, although biomethylation may remobilize this metal as tetramethyl lead. The BCF for aquatic organisms is 49.
Methylene chloride (Dichloromethane)	Volatilization is the principal forte from the surface water. The half-life ranges from less than one hours to several hours, depending on the agitation of the water. Biodegradation may occur in stagnant swamp water (cometabolism) but, generally, other forte processes are unimportant. This compound is not considered to be persistent. Bioaccumulative potential is low (BCF=5.0).
Zinc	Zinc is strongly sorbed to both organic and inorganic components of the sediment where it will be persistent. Zinc is bioaccumulated by all organisms. BCF for freshwater fish is 432.

SECTION 13

13.0 REFERENCES

1. Report to Congress on the Discharge of Hazardous Wastes to Publicly Owned Treatment Works. United States Environmental Protection Agency, Washington, D.C., February 1986.

2. Development Document for Proposed Effluent Limitations Guidelines and New Source Performance Standards for the Auto and Other Laundries, United States Environmental Protection Agency, Washington, D.C., (EPA draft document April 1974).

3. Modular Wastewater Treatment System Demonstration for the Textile Maintenance Industry, United States Environmental Protection Agency, Washington, D.C., January 1974.

4. Technical Support Document for Auto and Other Laundries Industry, United States Environmental Protection Agency, Washington, D.C., October 1979.

5. Development Document for Effluent Limitations Guidelines and Standards for the Auto and Other Laundries Point Source Category, United States Environmental Protection Agency, Washington, D.C., October 1980.

6. Guidance Document for Effluent Discharges from the Auto and Other Laundries Point Source Category. United States Environmental Protection Agency, Washington, D.C., February 1982.

7. Kaufman, R., "Wastewater Heat Recovery and Low Temperature Washing," Textile Rental, pp. 72-76, August 1985.

8. Riggs, C.L., and Sherrill, J.C., Textile Laundering Technology, Textile Rental Services Association of America, Hallandale, Florida, 1972.

9. Nemerow, N.L., Liquid Waste of Industry, Theories, Practices, and Treatment, Addison-Westey Publishing Company, Reading, Massachusetts, 1971.

10. Patterson, I.W., Wastewater Treatment Technology, Ann Arbor Science Publishers, Inc., Ann Arbor, Michigan, 1975. pp. 175-189.

11. Process Design Manual for Suspended Solids Removal-Technology Transfer, U.S. Environmental Protection Agency, Cincinnati, Ohio, January 1975. pp. 4-1, 4-2.

12. O'Meilia, C.R., "Coagulation and Flocculation." Physicochemical Processes for Water Quality Control, Chapter 2, W.J. Webster, Jr., ed. Wiley-Interscience, New York, New York, 1972. pp. 61-91.

13. *Wastewater Engineering, Collection, Treatment, and Disposal*, Metcalf and Eddy, Inc., McGraw Hill Book Company, New York, New York, 1972.

14. *Wastewater Treatment Plant Design, Manual of Practice No. 8*, Water Pollution Control Federation, Washington, D.C., 1977.

15. Tran, T.V., "Advanced Membrane Filtration Process Treats Industrial Wastewater Efficiently," *Chemical Engineering Progress*, March 1985.

16. Gils, G.J., Pirbazari, M., Sung-Huyn, K. and Shorr, J., "Treatment of Emulsified and Colloidal Industrial Wastewater Using a Combined Ultrafiltration Carbon Adsorption Process," Proceedings of the 39th Purdue Industrial Waste Conference, Purdue University, Lafayette, Indiana, 1984.

17. Bhattacharyya, D., Garrison, K.A., The, P.W.E., and Grieves, R.B., "Membrane Ultrafiltration: Wastewater Treatment Application for Water Reuse," Proceedings of the 39th Purdue Industrial Waste Conference, Purdue University, Lafayette, Indiana, 1975.

18. Noll, K.E., Haas, C.N., Schmidt, C. and Kodukula, P., *Recovery, Recycle, and Reuse of Industrial Wastes*, Lewis Publishers, Inc., Chelsea, Michigan, 1985. pp. 119-133.

19. Pinto, S.D., "Ultrafiltration for Dewatering of Waste Emulsified Oils," Proceedings, First International Conference, Lubrication Challenges in Metal Working and Processing, IIT Research Institute, Chicago, Illinois, 1978.

20. Paulson, D.J., Wilson, R.L. and Spatz, D.D., "Crossflow Membrane Technology and Its application," *"Food Technology*, pp. 77-111. December 1984.

21. Jeng, F., and Shih, C., "Treatment of Laundry Wastewater From a Nuclear Power Plant by Reverse Osmosis," Proceedings of the 39th Purdue Industrial Waste Conference, Purdue University, Lafayette, Indiana, 1984.

22. Miniturn, R.E., Johnson, J.S., Jr., Schofield, W.M., and Todd, D.K., "Hyperfiltration of Laundry Wastewater," *Water Research*, 8(11):921-926. 1974.

23. Bhattacharyya, D., Jumawan, A.B., Jr., Greives, R.B. and Witherup, S.O., "Ultrafiltration of Complex Wastewaters: Recycling for Nonpotable Use." *Journal of the Water Pollution Control Federation*, 846-861. May 1978.

24. "Memtek Corporation: The Technology of Today," *Industrial Launderer*, 36(11):70-73. November 1985.

25. *Process Design Manual for Upgrading Existing Wastewater Treatment Plants- Technology Transfer*, U.S. Environmental Protection Agency, Cincinnati, Ohio, October 1974.

26. *County Business Patterns*. U.S. Department of Commerce. 1978, 1982, 1985, 1986.

27. *Census of Service Industries*, U.S. Census Bureau. 1982.

28. *An Analysis of the Industrial Laundry Industry*. Institute of Industrial Launderers. 1987.

29. *The Industrial Laundry Industry and its Markets*. Institute of Industrial Launderers. 1987.

30. Stoll, Barry. Personal communication. Telephone conversation between Mark Lennon of Eastern Research Group and Barry Stoll, Administrator of the Alliance of Textile Care Associations (Washington, DC), on March 10, 1988.

31. *RMA Annual Statement Studies*. Robert Morris Associates. 1987. Philadelphia, PA.

32. *Industry Norms and Key Business Ratios*. Dun and Bradstreet Credit Services. 1987.

33. Troy, Leo; 1987. *Almanac of Business and Industrial Financial Ratios*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

34. *Economic Analysis of Proposed Effluent Guidelines and Standards in the Auto and Other Laundries Industry*. U.S. Environmental Protection Agency. Economic Analysis Branch, Office of Water Regulations and Standards. November 1981.

25. Process Design Manual for Upgrading Existing Wastewater Treatment Plants- Technology Transfer, U.S. Environmental Protection Agency, Cincinnati, Ohio, October 1974.

26. County Business Patterns. U.S. Department of Commerce. 1978, 1982, 1985, 1986.

27. Census of Service Industries, U.S. Census Bureau. 1982.

28. An Analysis of the Industrial Laundry Industry. Institute of Industrial Launderers. 1987.

29. The Industrial Laundry Industry and its Markets. Institute of Industrial Launderers. 1987.

30. Stoll, Barry. Personal communication. Telephone conversation between Mark Lennon of Eastern Research Group and Barry Stoll, Administrator of the Alliance of Textile Care Associations (Washington, DC), on March 10, 1988.

31. RMA Annual Statement Studies. Robert Morris Associates. 1987. Philadelphia, PA.

32. Industry Norms and Key Business Ratios. Dun and Bradstreet Credit Services. 1987.

33. Troy, Leo; 1987. Almanac of Business and Industrial Financial Ratios. Englewood Cliffs, NJ: Prentice-Hall, Inc.

34. Economic Analysis of Proposed Effluent Guidelines and Standards in the Auto and Other Laundries Industry. U.S. Environmental Protection Agency. Economic Analysis Branch, Office of Water Regulations and Standards. November 1981.

35. Kleper, M.H., R.L Goldsmith, and A.Z. Gollen. Demonstration of Ultrafiltration and Carbon Adsorption for Treatment of Industrial Laundering Wastewater. EPA-600/2-78-177, U.S. Environmental Protection Agency, Cincinnati, Ohio, August 1978.

36. Rosenthal, B.L. et al. Industrial Laundry Waste Water Treatment Study. Project #48, Massachusetts Health Research Institute, Inc., Boston, Massachusetts. April 1964.

37. Cogely, D.R. and B.A. Weschler. Occurrence and Treatability of Priority Pollutants in Industrial Laundry Wastewaters. Draft Final Report. Grant No. S-804367-01, U.S. Environmental Protection Agency, Cincinnati, Ohio. January 1978.

38. Guarino, V.J., and R.A. Bambenek. Development and Testing of a Wastewater Recycler and Heater. EPA-600/2-76-289. U.S. Environmental Protection Agency, Cincinnati, Ohio. December 1976.

39. Linen Supply Association of America. Report of 20 Member Plants. 1978. Unpublished.